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Management Control Systems...

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MANAGEMENT CONTROL SYSTEMS

A SHORT HISTORY FROM FAYOL TO FORRESTER

By

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TABLE OF CONTENTS

		Page
ILLUSTRATIONS		iv
PREFACE		v
Chapter I	THE FAYOLIAN CONCEPT OF MANAGEMENT CONTROL	1
II	SUBSEQUENT VIEWS OF CONTROL IN ORGANIZATIONS	18
	The "Principles" of Control	
	The Active Element in Management Control	
	The Informational Aspects of Control	
III	THE MANAGEMENT SCIENCE CONCEPT OF CONTROL IN ORGANIZATION	42
	The Origins of Management Science	
	The Methodology of Management Science	
	Information-Feedback Control Theory	
	The "Systems" Concept of Organization	
IV	SOME CONSIDERATIONS IN THE DESIGN OF MANAGEMENT INFORMATION AND CONTROL SYSTEMS	59
	Measurement of Information and Control System Performance	
	The Information and Control Spectrum	
	The Locus of Control	
V	SUMMARY AND CONCLUSIONS	96
BIBLIOGRAPHY		103

ILLUSTRATIONS

Figure		Page
1-1	Urwick's Tabular Presentation of Principles of Administration	10
2-1	Performance Deviation from Policy or Standard	28
2-2	Revision of Policy or Standard	30
2-3	Revision of Policy or Standard and Correction of Performance	30
2-4	A Two-part Management Information Flow	33
2-5	The Anatomy of Management Information	39
3-1	A Simplified Organization Chart	52
3-2	A Simplified Communications Chart of an Organization	52

PREFACE

Control, in the management sense, is as old as organization itself--and organization is said to have started when the world's population grew from one to two. Aristotle has stated in his discourse Politics: "He who is unable to live in society or who has no need because he is sufficient for himself, must either be a beast or a god . . . ." As Aristotle implies, it is difficult, if not impossible to exist outside of social relationships. Human association satisfies man's social needs and, in addition, amplifies human capacities through cooperative effort. "What one man cannot do, two can do; what one can do, two can do better."[1] Cooperative effort, however, involves some form of work division and whenever the tasks are divided, some means is necessary to assure performance in a manner that will achieve the common goal which is the basis for cooperation. This is the function of control. Control may be informal and a relatively simple matter, as in the case of two men moving a heavy stone or it may be a formal and complex system as is found in modern industrial enterprise. As organizations change, so must control within the organization:

> In the formative days of modern business enterprise management control presented little problem. Typically, the entrepreneur initiated his own plans, and made modifications when necessary. The goals of the firm were identically the goals of the proprietor. The

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[1]Henry H. Albers, Organized Executive Action: Decision-making, Communication, and Leadership (New York: John Wiley & Sons, Inc., 1961), p. 3.

recorded information needed by the top executive to run the business was minimal.[1]

As companies grew, control became more necessary for effective management. The efforts of many individuals required coordination and the plans of the top executives had to be executed through an extensive hierarchy of managers, supervisors, foremen and workers. An accurate "feedback" of information was required to determine if plans were being followed or should be modified.[2]

Control is an essential attribute of effective management. Yet the word "control" often evokes unpleasant images in men's minds. It has been said:

> Our whole concept of control is "naive," "primitive" and ridden with an almost retributive idea of causality. Control to most people (and what a reflection this is upon a sophisticated society!) is a crude process of coercion. A traffic policeman, for example, is alleged to be in "control." He is in fact, trying to determine a critical decision-making point on much too little information by a fundamentally bullying approach (because it is backed by legal sanctions).[3]

The problem as Rathe observes it, is that "'control' has just too many and too different meanings."[4] Outside the business world the terms

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[1]Charles P. Bonini, Robert K. Jaedicke, Harvey M. Wagner (eds.) Management Controls; New Directions in Basic Research, (New York: McGraw-Hill Book Company, 1964), p. ix.

[2]Ibid.

[3]Stafford Beer, Cybernetics and Management (New York: John Wiley & Sons, Inc., 1959), p. 21.

[4]Alex W. Rathe, "Management Control in Business," eds. Donald G. Malcolm and Alan J. Rowe, Management Control Systems (New York: John Wiley & Sons, Inc., 1960), p. 32.

"currency control," "pest control," "rent control" and "birth control" are frequently used. It is also said a politician "controls" votes and thereby exerts influence; a person "controls" his temper and thus suppresses something; a "control" valve regulates something; a football team wins through ball "control" or, therefore, by possessing something.

Control, in the management sense is also a term seeking definition. The vocabulary of business includes, among others, these usages:

Production Control

Quality Control

Budgetary Control

Safety Control

Labor Control

Inventory Control

Top Management Control

Forms Control

The common element in all of these terms is the word "control," yet each one is conceptually and operationally different.

The problem of the diversity of meanings of control has plagued writers and commentators in the field of management since the word first came to be associated with the administrative task. Management has been described as consisting of two elements--planning and controlling--or as many as forty-seven with control being prominent in most all interpretations of management. A number of descriptions of control, by various writers, appear in this paper. Common to most of these are the

following essential steps: (1) setting of goals and standards of performance, (2) gathering data and checking results to see how performance compares with the standards, and (3) initiating corrective action where actual results do not meet the standards.

This paper is concerned, principally, with "management control," a refinement in the description of the control function in organizations which has recently gained renewed interest. The term "management control" is an attempt to distinguish between the process of keeping day-to-day, functionally oriented operations, in conformance with plans (operational control), and the process of integrating the various operations into a common effort to achieve over-all objectives--which is the essence of management control.

A standardized definition of control, as it applies to the cooperative effort of individuals within organizations, may well develop quite independent of the less restricted use of the word. There has recently been developed in the field of science, however, a concept of control which emphasizes the similarities in control as it exists in the nervous systems of higher animals, electro-mechanical devices, and in social, political and economic organizations. The implications of this concept are far-reaching. To the extent that decision rules can be formalized and expressed quantitatively, automatic control of administrative processes within organizations is considered to be feasible. Some people, however, particularly those associated with traditional management thought, doubt that appreciable inroads in the area of automating management control

are possible or that Information-Feedback Control Theory or Cybernetics adequately describes the management process.

This paper is addressed to the question of whether the evolvement of Information-Feedback Control Theory, and its application to management, has modified or invalidated the basic concepts of the control function in management. The research method utilized in its preparation has been a review of the rapidly expanding collection of management literature dealing with the subject of control. This study, therefore, relies heavily upon the opinions of individuals knowledgeable in this field who have presented their views and experiences before academic seminars, professional societies and, through books and periodicals, before the general public. This research has led to the conclusion that management science, which is the application of the concepts and methods of physical science to the study of organizations, provides a useful means for viewing the management process and valid methods for testing and applying its postulations to the solution of management control problems. Management science, however, has not altered the basic concepts of what the control function in management is and how it is accomplished. Traditional management thought, although exhibiting considerable disarray, has been found to still provide a useful body of knowledge which, when combined with the contributions of those schooled in the physical sciences, can contribute to the development of effective management information and control systems.

The format to be followed in the presentation of the research and findings of this study is as follows:

Chapter I presents the concept of control developed by Henri Fayol, the first writer to specifically identify control as an element of management, and discusses the effect of Fayol's work on subsequent management thought.

More recent views of management control are included in Chapter II within a general framework of: (a) The Principles of Control, (b) The Active Element in Control, and (c) The Informational Aspects of Control. Although the writings presented comprise only a small portion of the extensive literature on the subject, they have been selected as representative of current management thought.

Chapter III discusses the origins and contributions of management science with specific attention to Information-Feedback Control Theory and to the holistic or systems approach to management.

In Chapter IV, some of the more important considerations which must underlie the design of management information and control systems are discussed. The contributions of both management art and management science are presented in relation to essential considerations in systems design to emphasize the significance and limitations of both. A brief discussion concerning development of a unified theory of management control is also included.

A summary of the research and the conclusions reached appears in Chapter V.

The terms "traditionalist" and "management scientist" are used in this paper to identify scholars, academicians and practitionners associated with contemporary management thought. The former refers to those who have generalized on the management process from observation and experience, the latter those who have conceptualized from analogy and from experimentation. Although both terms can be found in the literature of management, neither are entirely satisfactory discriptions. One implies looking backward, the other looking forward, a distinction that is not intended. The terms are used in this paper only as a convenience for expressing the different frames of reference based on the backgrounds and specific interests of the individuals thus categorized.

I wish to take this opportunity to express my appreciation to those who have made this research project possible--to the officers of the United States Navy for allowing me to pursue my graduate studies, to The George Washington University and its faculty members for extending the opportunity to participate in the Master's degree program. Specific gratitude is expressed to those who assisted in this effort--to Dr. James G. Brown who provided the initial impetus to this study, to Dr. Karl E. Stromsem for advising me in the research of this paper and for the helpful suggestions he offered. Sincere and affectionate appreciation is also given to my wife Pat for her patience and encouragement and to our three children who exhibited less patience but, nevertheless often expressed empathic concern regarding the amount of "homework" the project has involved.

CHAPTER I

THE FAYOLIAN CONCEPT OF MANAGEMENT CONTROL

Henri Fayol, considered by many to be the father of modern management thought, was born in France in 1841.[1] At the age of 19 he graduated as a mining engineer from the National School of Mines at St. Étienne and was placed as an engineer at the Commentry coal mines of the Commentry-Fourchambault Company (Comambault) in 1860. He remained with this organization throughout his business career, retiring as the Managing Director in 1918, but continuing as a director of the company until his death in 1925 at the age of 84.

At the time of his appointment to the chief executive position in 1888, the company was close to bankruptcy. No dividends had been paid for several years; its metallurgical works were sustaining heavy losses and its major coal field was nearing depletion. Fayol, by his practical as well as scientific skill, was able to not only stem the tide of losses but to expand the company, while building a strong financial base and a continuous record of dividends and profits.

Speaking of Fayol's business career, Urwick points out: "The success with which he carried out . . . [his duties as Managing Director

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[1]The biographical material on Henri Fayol which appears in this chapter is from L. Urwick's Foreword to Henri Fayol's General and Industrial Management (Storrs translation) published by Sir Isaac Pitman & Sons, Ltd. in 1949.

of Comambault] is one of the romances of French industrial history."[1]

After his retirement from active management, Fayol devoted his efforts to publicizing the theory of management which he developed from both his personal observation and long experience. Although trained as an engineer, Fayol realized early in his career that management of a large industrial organization required additional skills far different from those essential in engineering. A manager, he observed, must be able to formulate plans and to organize the efforts of many people to achieve these plans. This was a function far different from the science of engineering and led to his identification of the administrative function as distinct from the technical function in business organizations.

Fayol's best known treatise on the subject of management was first published in France in 1916 under the title Administration industrielle et générale. It was reprinted in French several times, but an English translation was not available until 1929 when J. A. Coubrough of The British Xylonite Company, Ltd., completed a translation of the work which he had undertaken voluntarily. This translation was published by the International Institute of Management at Geneva; however, few copies were available either in England or the United States. Even as late as 1945 most libraries in the United States, including The Library of Congress, did not have copies of Fayol's book, either in French or English.[2] A more widely distributed English translation by Miss Constance

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[1]Henri Fayol, General and Industrial Management. Trans. by Constance Storrs. (London: Sir Isaac Pitman & Sons, Ltd., 1949), p. vii.

[2]Norman M. Pearson, "Fayolism as the Necessary Complement of Taylorism," American Political Science Review, February 1945, p. 80.

Storrs, however, appeared in 1949 under the title General and Industrial Management.

Until publication of the Storrs translation few practitioners or students of management either in England or the United States were familiar with Fayol's work, although one of his papers, "The Administrative Theory of the State," was translated by Miss Sarah Greer and included in a collection edited by Luther Gulick and Lyndall Urwick which was published in 1937.[1]

Fayol's work, although not widely known to the English speaking world until nearly a quarter century following his death, has had a profound impact on the study of management both in this country and in the British Isles. Fayol maintained that management should be a part of the curriculum of institutions of higher learning. He decried the lack of management teaching in the technical schools of his time, insisting that managerial ability should be acquired in the same manner as technical ability--initially in the schools and later in the workplace. His book represented an attempt to develop a universal theory of management, applicable both in government and private business which could be a basis for teaching this most important subject.[2]

Fayol's Elements of Management, and to some extent his Management Principles, have been incorporated in many of the recent texts describing

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[1] L. Gulick and L. Urwick (eds) Papers on the Science of Administration (New York: Institute of Public Administration, 1937).

[2] Fayol, op. cit., Part I, "Necessity and Possibility of Teaching Management."

the practices or processes of management.[1] Professor Koontz, in a tribute to Fayol, states:

> . . . a study of Fayol's monograph, with its practical and clear approach to the job of the manager and his perception of the universality of management principles, discloses an extraordinary insight into the problems which beset business management today. Indeed, even though the thinking of certain students of management was clearly affected by Fayol long before his work was brought to the attention of the general public, one regrets that all serious students of business management did not have the advantage of Fayol's analysis.[2]

Fayol's contribution to management theory is from the viewpoint of top management and throughout his work is found a central theme which (1) emphasizes the distinction between the management function and the other activities which occur in public and private enterprises, and (2) indicates the direct relationship between the amount of time an individual devotes to the management function, in comparison with the other activities, especially the technical function, and his position in the "scaler chain" of the organization. Fayol conceived management to be but one of the six functions occurring in most enterprises. These functions--technical, commercial, financial, security, accounting and management--in total comprise the "government of the enterprise." He perceived the management function as distinct from the other five essential functions and cautioned the reader: "It should not be confused with government."

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[1]For example, see Harold Koontz and Cyril O'Donnell, Principles of Management: An Analysis of Managerial Functions (New York: McGraw-Hill Book Company, 1955), and William H. Newman and Charles E. Summer, Jr., The Process of Management: Concepts, Behavior, and Practice (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1961).

[2]Koontz and O'Donnell, op. cit., pp. 22-23.

"To govern is to conduct the undertaking towards its objective by seeking to derive optimum advantage from all available resources and to assure the smooth working of the six essential functions."[1]

Although management is only one of the six functions of government of the enterprise, as Fayol indicates, it has "such a large place in the part played by higher management that sometimes this part seems exclusively managerial."[2] Fayol speculated that the heads of large industrial concerns and government departments spend half or more of their time on managerial activities and devote no more than ten per cent of their time on each of the remaining five functions.[3]

As indicated previously, Fayol's elements of management have been used in essentially the same form by recent writers to describe the management function of executives. Fayol incorporates these elements in a definition of management in which he states:

> To manage is to forecast and to plan, to organize, to command, to co-ordinate and to control. To foresee and provide the means for examining the future and drawing up the plan of action. To organize means building up the dual structure, material and human,

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[1]Fayol, op. cit., p. 6. The earlier Coubrough translation employed different terminology than the subsequent Storrs edition. Coubrough used the word "management" in lieu of "government" to describe the total workings of the six functions. Additionally, Coubrough translated the sixth function as "administration" directly from the French word, whereas Storrs used the term "management." Urwick, in his foreword to the Storrs translation, points out that there is no exact equivalent to the word "management" in the French language. He states that Miss Storrs and her publishers decided on the substitution of management for administration because of the tendency, particularly in his country, to attempt to distinguish between management, as an activity of industrial or commercial enterprises, and administration, concerned with governmental activities. Fayol, op. cit., pp. xii-xv.

[2]Ibid., p. 6.

[3]Ibid., p. 8.

> of the undertaking. To command means maintaining activity among the personnel. To co-ordinate means binding together, unifying and harmonizing all activity and effort. To control means seeing that everything occurs in conformity with established rule and expressed command.[1]

The object of control, again in Fayol's own words,

> . . . is to point out weaknesses and errors in order to rectify them and prevent recurrence. It operates on everything, things, people, actions. From the management standpoint it must be ensured that a plan does exist, that it is put into operation and kept up-to-date, that the human organization is complete, the summarized personnel charts in use, and that command is exercised in line with principles, that co-ordinating conferences are held, etc., etc., . . .[2]

He also relates control to the other functions within the organization. Control from a technical standpoint, for example, would include the reporting and evaluation of production progress. Control, as it occurs in conjunction with the internal supervision of the various functional departments, is a responsibility of the head of those departments and as such is not a direct concern of higher management. Management control as viewed by Fayol is concerned only with those matters which significantly affect interrelationships of the various functional areas and the smooth operations of the concern as a whole. It is in this connection that he stresses the potential danger of an infiltration of management control into the operation of the various departments. If allowed to occur this encroachment results in a form of dual management--"on the one side there is irresponsible control . . . capable at times of doing widespread harm; on the other is the operating department, bereft of all but weak means of defense against

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[1] Ibid., pp. 5-6.

[2] Ibid., p. 107.

hostile control."[1]

To prevent the intrusion of management control into operations, Fayol states that the "powers of control" should be clearly defined at the outset including the limits of authority of those executives concerned with the exercise of control and that control procedures must also be continuously monitored by higher authority.[2]

Fayol concluded his remarks on the subject of control with the observation that, when properly implemented, control can be an important adjunct to management and can assure the receipt of necessary data which might not otherwise be forwarded by those in subordinate supervisory positions.[3]

One of the earliest acceptances of Henri Fayol's concepts of management is found in Lyndall Urwick's The Elements of Administration published in 1943.[4] Utilizing a framework of Fayol's elements and principles of management and list of "managerial duties," Urwick brought together various management theories, principally those contained in the writings of Frederick W. Taylor, J. D. Mooney and A. C. Riley, and Mary

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[1] Ibid., p. 109.

[2] Ibid.

[3] Ibid.

[4] L. Urwick, The Elements of Administration (New York: Harper & Brothers, 1943).

Parker Follett,[1] in addition to Fayol. With block diagrams showing a logical flow from one principle to another and a tabular summary of the various elements, principles and duties, Urwick attempted to demonstrate an inherent unity among the various theories of management.[2] He undertook to combine principles of management, the processes employed for their achievement, and the effects of these processes into the "logical scheme" which Mooney and Riley adapted from the writings of Louis Anderson.

> First, that every principle has its process and effect, and second, that if these have been correctly identified, the process and effect will, in their turn, be found to have, each of them, a principle, process and effect.[3]

Following this pattern, Urwick expands Fayol's element of Planning to include both forecasting and planning (as did Storrs), and adds "Appropriateness," the second of Fayol's Administrative duties. At this point he states:

> Thus the logical square is completed with the exception of the principle underlying the whole process of Administration Management . And here it is not unduly straining probability to imagine that Fayol himself would have inserted Investigation.[4]

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[1] F. W. Taylor, The Principles of Scientific Management (New York: Harper & Brothers, 1911); F. W. Taylor, "Shop Management," Transactions of the American Society of Mechanical Engineers, June 1903, pp. 1347-1480; J. D. Mooney and A. C. Riley, Onward Industry! (New York: Harper & Brothers, Publishers, 1931); and Henry C. Metcalf and L. Urwick, Dynamic Administration: The Collected Papers of Mary Parker Follett (New York: Harper & Brothers, Publishers, n.d.).

[2] Urwick in his book uses the term "administration" in lieu of "management." He regretted the substitution of the term management for administration in the subsequently published Storrs translation of Fayol's Administration industrielle et générale, citing the lack of a precise meaning for the term management and the need to standardize terminology.

[3] Mooney and Riley, op. cit., p. 45.

[4] Urwick, op. cit., p. 17.

Urwick summarizes to this point by saying:

> These three principles, each with its corresponding process and effect, make up the perfect logical square summarising sic the main aspects of Administration. The underlying principle on which the whole art rests is Investigation. It enters into process with Forecasting and the effect is a Plan or Planning. Forecasting has its own principle, namely Appropriateness. It enters into process with Organization, since the first thing you do when you look ahead is to provide the means, human and material, to meet the future situation which you foresee. Its effect is Coordination. Finally, Planning finds its principle in Order, enters into process with Command, and the effect is Control.[1]

Urwick's "Square of Nine" is shown in Figure I-1, page 10. It is perhaps unfortunate that Urwick chose this particular method of presentation. At the time of its publication, his book was regarded as strong evidence that a science of management would ultimately be possible.[2] Fayol and Taylor however viewed enterprise from the antipodean positions of workshop and the executive suite. And Mary Parker Follett focused on the human aspects of management. The considerable risk of attempting to combine various theories of management developed independently by individuals of differing perspectives is obvious and nowhere is this more evident than in Fayol's concept of control. Throughout his book, Fayol emphasizes the reporting or intelligence gathering aspects of control and the correction of deviations from plan rather than the exercise of directing or restraining power which Urwick's statement "Command takes effect in Control" implies. It was within the latter connotation of the

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[1] Ibid., p. 18.

[2] Marshall E. Dimock. Review of The Elements of Administration by L. Urwick, The American Political Science Review, February 1945, pp. 180-181.

Figure 1-1

L. URWICK'S TABULAR PRESENTATION OF PRINCIPLES OF ADMINISTRATION[a]

1. PRINCIPLE	2. PROCESS	3. EFFECT
1. INVESTIGATION	FORECASTING	PLANNING
All scientific procedure is based on investigation of the facts, which thus becomes the first principle of administration.	Investigation enters into process with forecasting.	And takes effect in a plan.
FORECASTING must be in terms which correspond with the realities of the situation, i.e. with the general objectives and broad policy of the undertaking. It therefore finds its underlying principle in		
2. APPROPRIATENESS	ORGANIZATION	CO-ORDINATION
See that the human and material organizations are suitable for the undertaking.	Forecasting enters into process with the provision of a suitable organization.	And takes effect in co-ordination.
PLANNING The purpose of planning is to secure systematic action in accordance with the general objectives and broad policy of the undertaking. It therefore finds its underlying principle in		
ORDER	COMMAND	CONTROL
Ensure human and material order.	Planning enters into process with command.	And takes effect in control.

[a]Source: L. Urwick, The Elements of Administration, New York: Harper & Brothers Publishers, 1944, p. 19.

word control that he included Follett's concept of control in management with that of Fayol. The writings of Mary Parker Follett are singularly remarkable for their emphasis on the sociological factors in contrast to the mechanistic aspects of organization well before wide recognition of their applications in business organizations developed. She theorized that industrial organizations, to be successful, "must be constructed and operated as to give play to the motivating desires of the individual and of the group."[1] Unfortunately Miss Follett does not define the term control but it would appear its meaning, as used in her writing, is similar to that adopted by the sociologist Dowd who, in 1936, wrote: "control in any organization involves the exercise of authority, the formulation of a purpose, the fixing of standards, and the enforcement of discipline."[2]

A definition similar to Dowd's is implied in Miss Follett's development of the thesis that effective control must be based on and result from coordination rather than coercion. Employing the example of self-control in human physiology, she wrote:

> . . . the organizing activity <u>is</u> the directing activity. The interacting <u>is</u> the control, it does not set up a control, that fatal expression of some writers on government and also some writers on business administration. I cannot get up in the morning, I cannot walk to my work, without that co-ordination of muscles which is control.[3]

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[1]George Filipetti, <u>Industrial Management in Transition</u> (Homewood, Ill.: Richard D. Irwin, Inc., 1953), p. 259.

[2]Jerome Dowd, <u>Control in Human Societies</u> (New York: D. Appleton-Century Company, Incorporated, 1936), p. 151.

[3]Metcalf and Urwick, <u>op. cit.</u>, pp. 202-203.

That Urwick included both Mary Parker Follett's rules for co-ordination, Frederick W. Taylor's Exception Principle of reporting only deviations from standard, as well as Fayol's principles and managerial duties relating to control as an intelligence gathering element of management, is no less remarkable than the fact that he intersperses examples and comments which support the various concepts of control held by these writers. For example, he provides a rather interesting illustration of control as practiced in the British Army to overcome a tendency to be "lightfingered" with public funds. From the Restoration to almost the end of the 19th century army regiments were treated as if they were the property of the Colonel-in-Command. He received a capitation grant by the government on the basis of personnel strength to feed and clothe the men under his charge. Whatever remained after these necessities were provided was available to the colonel for his own use. At one point, Urwick points out, colonels of regiments were allowed officially to improve their own lots by maintaining a number of fictitious names of men on the strength of which they could draw the capitation fee. This system was open to abuse and, to eliminate its practice, a system of musters was introduced. Visits were made to each regiment by representatives of the government and at that time the colonels were required to parade the full regiment so that a head count could be made for confirmation with the reported strength of the unit. Urwick states: "There are many amusing stories of hasty and temporary recruitment of the maimed, the halt and the blind, to meet the requirements of an unexpected muster . . . . A

muster was, of course, a form of control"[1]

Elsewhere he states:

> Indeed the conception of control as a principle and some knowledge of its methods are probably more widespread and generally developed in human undertakings than any of the other aspects of administration which have been discussed. . . . administrators all down the ages have been interested in methods of keeping themselves informed as to the results of their plans and orders.[2]

If a muster is a <u>form</u> of control, this writer wonders what its <u>method</u> would be. Again quoting Urwick:

> The various aspects which Fayol has analysed, if arranged in order of time, make the segments of a complete circle. Forecasting leads to planning. The next operation is organization, which issues in co-ordination. Then comes Command and, finally, Control, next to Forecasting again, and appropriately next to it, since much of the material thrown up by a modern system of control is as valuable for looking forward as for reviewing the past. It is the factual basis of forecasting the next period ahead.[3]

Later he states:

> Indeed, additional mechanism creates further problems of internal co-ordination, so that a large proportion of the efforts of all concerned is devoted to keeping in step rather than to stepping out.
>
> These considerations led her [Follett] to four broad rules or principles, which should guide the administrator in securing co-ordination, which, by definition is control.[4]

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[1]Urwick, <u>op. cit.</u>, pp. 98-99.

[2]<u>Ibid.</u>, p. 97.

[3]<u>Ibid.</u>, p. 102.

[4]<u>Ibid.</u>, p. 113.

Urwick nowhere in his book acknowledges any lack of comparability between the various concepts of control. Parts I and II of Fayol's General and Industrial Management are quite brief, totaling only one hundred and ten pages. Part III, in which Fayol promised to cite examples of the applications of the various elements of management, was never written. It is, therefore, possible that Urwick misconstrued Fayol's notion of control. Perhaps the clearest statement of Fayol's concept of control was contained in his paper, "The Administrative Theory of the State," included in a collection edited by Gulick and Urwick. In this paper, prepared for presentation before the Second International Congress of Administrative Science at Brussels in 1923, he wrote:

> To prepare the operations is to plan and organize; to see that they are carried out is to command and co-ordinate; to watch results is to control . . . . Control is the examination of results . . . control compares, discusses and criticizes; it tends to stimulate planning, to simplify and strengthen organization, to increase the efficiency of command and to facilitate co-ordination.[1]

Confusion with respect to the exact meaning of management control continues to the present time. Captain E. S. L. Goodwin of the University of Michigan has researched the contemporary usage in Fayol's time of the French word "controler" which Fayol used for the sixth element of management. He found that dominant meaning of "controler" was

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[1]Gulick and Urwick, op. cit., p. 103.

checking, comparing and verifying and that the idea of directing, restraining, using overriding power, the usual meaning of the English word control was not applicable.[1] Goodwin, accordingly, believes the confusion about what constitutes management control is attributable in part to a mistranslation by Coubrough and suggests that surveillance would be a more appropriate term.

As Professor Koontz has said, Henri Fayol exhibited an "extraordinary insight" into the problems of modern management. The impact of his work, however, was dulled by an unfortunate chain of events which included:

1. His failure to complete Part III of the book. Parts I and II were intended to establish the necessity and possibility of management teaching and to provide a framework of elements, principles and duties to be used in management instruction. An expanded discussion of the elements, principles and duties, as well as examples of their application, were to have been included in Part III.

2. The impreciseness of the translation from French to English which resulted in the use of the emotionally charged word "control" rather than one which carries the connotation of checking, verifying or comparing and more appropriately matches the author's intended meaning.

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[1] E. S. L. Goodwin, "Control: A Brief Excursion on the Meaning of a Word," Michigan Business Review, January 1960, p. 16.

3. The general unawareness in the English speaking countries of Fayol's work until nearly a quarter century after his death.

4. Urwick's early attempt to bludgeon a fit of generally unrelated theories of management developed by writers whose work proceeded independently of each other, who viewed the enterprise from greatly dispersed vantage points and focused on different aspects of management. Nowhere is this lack of fit more in evidence than in the case of management control.

A careful reading of either of the translations of Fayol's Administration industrielle et générale will show that Fayol's concept of control emphasized the checking-up or surveillance aspect of management rather than a restraint or dominating component. As such, control is unrelated either to Urwick's theory that command results in control or Follett's concept of effecting control through co-ordination rather than coercion. This is not to say that Fayol's and Follett's theories of management were incompatible--both, for example, recognized the need for co-ordination in organizations--but their views on control which were based on entirely different meanings of the word are incompatible.

Goodwin charges Coubrough, the first translator of Administration industrielle et générale, with primary responsibility for the confusion which today surrounds the word control when used in the management sense. To a large extent Urwick must share in the blame for his book, Elements of Administration, which preceded publication of the more widely

distributed Storrs translation, misrepresented Fayol's concept of control, and probably preconditioned many readers to an erroneous interpretation of Fayol's remarks concerning management control.

Only after reemphasis of the intelligence gathering or reporting aspects of management control, and the corresponding deemphasis of the emotionally inflammable, domineering aspects, did a true identification of management control and control systems begin to emerge. In some respects this represents a reapproachment to Fayol. In the following chapters, these concepts of control in management will be discussed.

CHAPTER II

SUBSEQUENT VIEWS OF CONTROL IN ORGANIZATIONS

In the previous chapter it was developed that Fayol's sixth element of management denoted an idea far different from the concept of control in society and organizations which had grown up, quite independently, in the English speaking regions. The semantics difficulties, however, have persisted. In 1950 Jackson Martendell wrote:

> So far . . . I have not talked of "control" at all; I have talked of "measurements." This was intentional. For "control" is an ambiguous word. It means ability to direct oneself and one's work. It can also mean domination of one person by another. Objectives are the basis of "control" in the first sense; but they must never become the basis of "control" in the second, for this would defeat their purpose. Indeed, one of the major contributions of management by objectives is that it enables us to substitute management by self-control for management by domination.[1]

No serious student of management, of course, has advocated management by domination but Martendell's statement illustrates the wide range of possible interpretations of management control, covering a whole spectrum from the broadest possible whereby, as Rathe points out, control has become completely synonymous with "management"[2] to extremely limited applications

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[1]Jackson Martendell, The Scientific Appraisal of Management (New York: Harper & Brothers, 1950), p. 267.

[2]Alex W. Rathe, "Management Control in Business," Management Control Systems, ed. Donald G. Malcolm and Alan J. Rowe (New York: John Wiley & Sons, Inc., 1960), p. 32.

such as quality assurance, cost control, and inventory management. There has also been a tendency to consider those aspects of management concerned with planning and review, and command and follow-up as management control. Budgeting and financial review have also been titled control as has production scheduling.[1]

There is inherent in all control systems some form of information gathering and reporting which, it may be implied, will be followed by a review or analysis of the data and some appropriate action. Many experts will insist that the control phase in management begins with the gathering of data and ends with review and analysis of this data by its comparison with pre-established standards. Others will insist with equal vehemence that control must include the setting of the standards for comparison and the implementation of the action called for by the information generated in the process of controlling. The parameters of control, however, assume

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[1]For some of these various concepts of control the reader is referred to the following published works:

Erwin Haskell Schnell, Technique of Executive Control (8th ed. New York: McGraw-Hill Book Company, Inc., 1957). ("Control is largely made up of the flow of orders and instructions in one direction and the flow of reports and comments in the other," p. 2.)

T. G. Rose and Donald E. Farr, Higher Management Control (New York: McGraw-Hill Book Company, Inc., 1947.) (Control through financial analysis.)

U. S. Army Headquarters, Army Service Forces Control Manual, Vol. 1, Fundamentals of Control, 1943 ("A control office is very similar to a management engineering firm in private business," p. 2).

Robert W. Miller, "How to Plan and Control with PERT," Harvard Business Review, March-April 1962, pp. 93-104. (Production scheduling techniques.)

less importance if the management process is conceptualized as cyclical in nature as described by Urwick,[1] or as a network wherein ". . . all of the functions of the manager are so closely interrelated that it is difficult in practice to ascertain where one function ends and another begins . . . because the operating manager performs all of them virtually at the same time."[2]

As did Fayol and Taylor, modern writers often look upon the manager's job from different vantage (or disadvantage) points which lead them to widely varying concepts of the role of control in business organizations. It would appear therefore, that an attempt to categorize these viewpoints would be meaningful only if the resultant groupings were on the basis of "key ideas" rather than the perspective of the observer. The following groupings, which include only a portion of the literature of management control, are intended only to indicate the major points of emphasis of each author and are not to imply that the views of writers shown in one category are not complimentary to those of other authors. The categories selected for this analysis are (a) the principles of control, (b) the active element in control and (c) the informational aspects of control.

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[1]Urwick, op. cit., p. 102.

[2]Harold Koontz, "Management Control: A Suggested Formulation of Principles!" California Management Review, Vol. I (Winter, 1959), p. 44.

The Principles of Control

Control, according to Professor Harold Koontz, has been . . . "one of the most widely discussed and studied areas of management." "Yet," he states, "it is a functional area in which little attempt has been made to formalize principles that might be useful to practicing managers, helpful in training them, and suitable for guiding research."[1] Koontz proposes fourteen "principles" of control which, he believes, if generally adopted, can provide the conceptual framework from which a useful body of control knowledge can be developed. These are:

1. Principle of Assurance of Objective. "Control must contribute to the realization of objectives by detection of deviations easily and in a manner that will indicate the required corrective action."[2]
2. Principle of Efficiency of Control. The control technique must detect and make corrective action possible with the minimum of "unsought consequences" such as increasing costs, negating authority delegations, lowering morale, stifling creativity, and slowing deliveries.
3. Principle of Control Responsibility. Control must be exercised only by those responsible for the execution of plans.
4. Principle of Future Control. Control should have as its purpose the prevention of present and future deviations from plans.

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[1] Ibid., p. 47.

[2] Ibid., p. 50.

There has been a tendency, Koontz notes, to regard control as "looking back" because so often it has been based on statistical and accounting data referring to past periods rather than on forecasts and predictions of future events.

5. Principle of Direct Control. The most effective control technique is the assurance that qualified subordinates fill all key positions.
6. Principle of Reflection of Plans. Control must be tailored to the character and structure of plans.
7. Principle of Organizational Suitability. Controls must reflect the structure of the organization. The controls employed must be geared to the authority and responsibility of individual managers.
8. Principle of Individuality of Controls. What is meaningful to one manager may not be so to another.
9. Principle of Standards. Every plan must be capable of objective, accurate and suitable measurement.
10. Principle of Strategic Control Points. Measurement must be effected at the point or points which will best indicate the level of performance.
11. The Exception Principle. Efficiency dictates that managers devote their attention primarily to significant exceptions.
12. Principle of Flexibility of Controls. Controls should be flexible enough to remain usable despite failure of the plan

itself and the necessity to reframe objectives.

13. Principle of Review. Controls, if they are to remain valid and effective, must be periodically reviewed for suitability.

14. Principle of Action. Control measures can be justified only if action is taken (through appropriate planning, controlling, organizing, staffing or directing) to correct the deviations which are experienced or indicated.[1]

A more recent attempt at formulation of control "principles" is contained in Louis A. Allen's book, The Management Profession. The author, who is president of a management consulting firm, has based this study on twelve years of research encompassing the observation of 385 companies and 12,000 managers. Allen states somewhat empirically that (1) management is a profession based on science and (2) there can be developed universally applicable principles of management. The "Allen Principles of Control"[2] are as follows:

1. Principle of Least Cause. In any given group of occurrences, a small number of causes will tend to give rise to the largest proportion of results.[3]
2. Principle of Point of Control. The greatest potential for control tends to exist at the point where action takes place.[4]

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[1]Ibid., pp. 50-55.

[2]Louis A. Allen, The Management Profession (New York: McGraw-Hill Book Company, 1964), pp. 318-324.

[3]Ibid., p. 318.

[4]Ibid., p. 319.

The responsible manager is in the best position to determine what information he requires and when it must be available. In the past, these determinations, according to Allen, have often been "assumed by default" by controller departments with the result that the operating manager has received data which he neither understood nor required. Part of the problem has been that each functional unit in the business, within the framework of company policy and procedural guidance, largely planned and controlled its own operations. Coordination was then accomplished by direct liaison of middle-level managers and through committees. The alternative which is now made feasible, and indeed more necessary by the installation of large capacity data processing equipment, is to consolidate the planning and control system design and data generation facilities at the corporate staff level. In this manner each plan can be developed within the framework of the overall company objectives, and a system of data gathering and control meeting requirements of each level of management can be developed as an internal part of the plan.[1]

The Active Element in Control

Jerome considers most of the problems as well as the opportunities facing the manager in today's world to be the result of either "the complexity of society or its inclination to rapid change."[2] If society were static there would be little need for control -- the past would be an

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[1] Ibid., pp. 322-323.

[2] William Travers Jerome, III, Executive Control -- The Catalyst (New York: John Wiley & Sons, Inc., 1961), p. 4.

adequate guide for the future. A manager, therefore, must be able to coordinate the diverse influences and activities which make up his environment. "Business controls," Jerome states, ". . . represent the pattern of activity followed by the skilled executive in order to achieve some mastery over his environment."[1] This is accomplished by (1) understanding the problems created by complexity and change and (2) developing useful ways to handle these problems. "The primary purpose of a system of control," Jerome goes on to say, "is to set the stage for action."

> The setting of this stage involves the creation of an environment in which the energies, the loyalties and the imagination of people will be released in order to accomplish the given ends or objectives of the business . . . . In this sense, planning, programming and organizing are part of the process of setting the stage.[2]

Control has its basis in measuring and reporting but its significance is more far reaching. Control is less concerned with catching errors or correcting deviations than in preventing errors and recognizing potentials. A system of common measurement enables managers to objectively appraise the effectiveness of subordinates. Control also simplifies communications, providing a common language especially in quantitative matters. Control is the element that makes decentralization of authority and responsibility possible, Jerome continues, yet it is equally important in a highly centralized organization, for under both there is need for measures of performance which will dictate where to invest limited resources and to show the success or failure of current units and the potential of new ones. The nature of

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[1] Ibid., p. 34.

[2] Ibid., p. 70.

the controls employed will vary between centralized and decentralized operations but not the factors which make it necessary.[1]

The active or dynamic aspect of control is also emphasized by Dauten, Gammill and Robinson.[2] "Effective control, like effective managing," they state, "is active, dynamic and evolving. This means that control cannot be accomplished indefinitely by formula except in a strictly stable situation."[3]

> Control as an over-all process implies all of the following: checking, evaluation, pre-planning, formulation of objectives, setting policies, organizing, determining systems and procedures and standards and methods, guiding, directing, motivating, bringing about coordination, restraint, correction, removing obstacles to the path of goal attainment, and reformulating objectives.[4]

The authors recognize two aspects of control, (1) that having to do with reorganizing operational activities to achieve performance standards and (2) the more forward looking aspect having to do with re-planning or the modification of objectives, policies, systems, procedures and budgets. The effects of the exercise of control in this context are illustrated in the diagrams which follow. In figure 2-1, page 28, the deviation at point A is slight and of little significance; however, the deviation at point B

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[1] Ibid., p. 6.

[2] Paul M. Dauten, Jr., Homer L. Gammill, and Stanley C. Robinson, "Emerging Concepts of Managerial Control," Current Issues and Emerging Concepts in Management: Readings from the Academy of Management, ed. Paul M. Dauten, Jr., (Boston: Houghton Mifflin Company, 1962), pp. 136-150.

[3] Ibid., p. 141.

[4] Ibid.

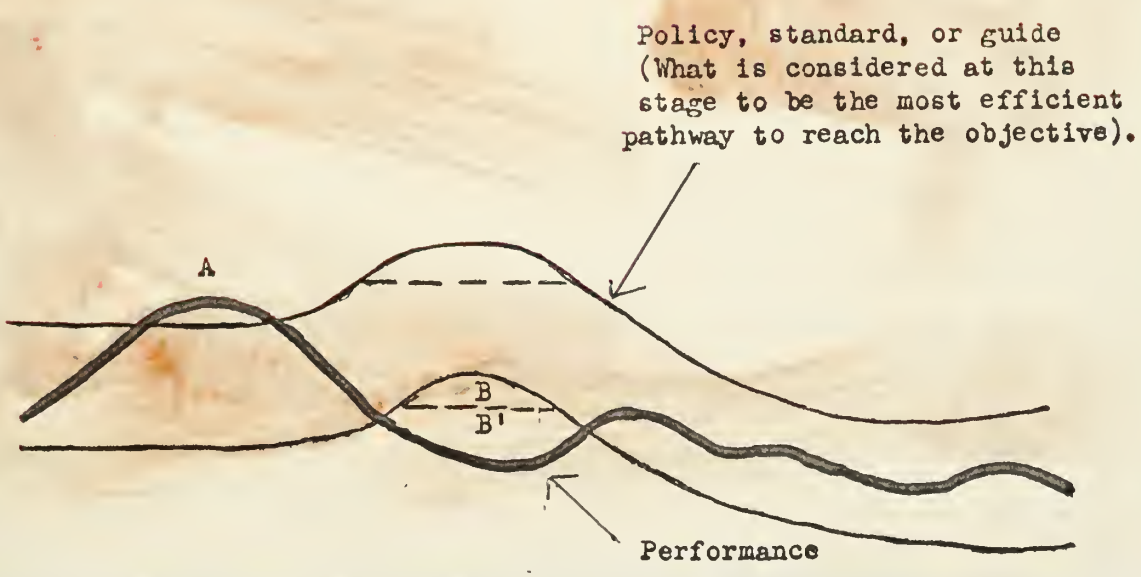

Fig. 2-1.--Performance deviation from policy or standard[a]

[a]Source: Dauten, Gammill, and Robinson, op. cit., p. 139.

is of a magnitude to warrant investigation. An analysis indicates that it consists of a correctible element B' and an uncorrectible element B that implies the original standard may be improper. As a result of this analysis, it is determined that policy or control standards should be modified. The original performance, compared to the new policy or guide lines is shown in figure 2-2. The deviation at B' is the same correctible element shown in figure 2-1.

Correction of the deviation, figure 2-3, page 30, results in performance, which except for the slight departure at point A is well within acceptable tolerances. Although the authors do not point this out, the deviation B' may have occurred from over-correcting to prevent further deviation at point A. Irrespective of the cause, however, the corrective action to prevent the overrun at point B should be initiated relatively close to point A. The authors emphasize this aspect by stating that measurements should be taken at the critical points where performance is most likely to indicate deviation from plan. The authors also state that the control readings must be promptly reported to the appropriate individual with authority to initiate corrective action.

Information Aspects of Control

A sharpened focus on management control together with the availability of improved means for processing data has caused more perceptive investigation of management information requirements. This, in turn, has resulted in a clearer distinction between control data and other types of management information.

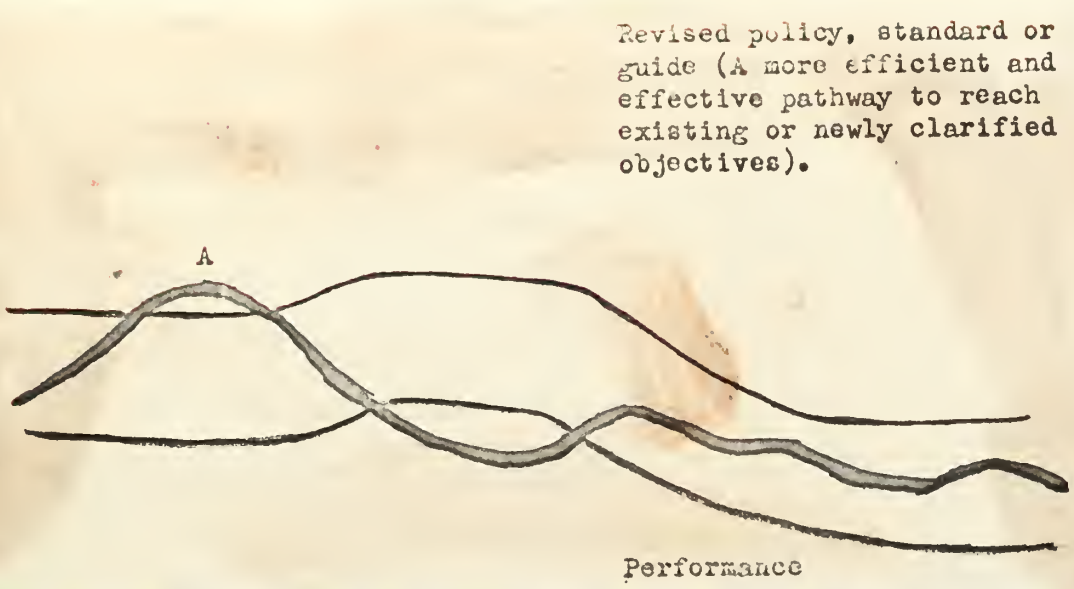
Revised policy, standard or guide (A more efficient and effective pathway to reach existing or newly clarified objectives).
A
Performance

Fig. 2-2.--Revision of policy or standard[a]

[a]Source: Dauten, Gammill, and Robinson, op. cit., p. 140.

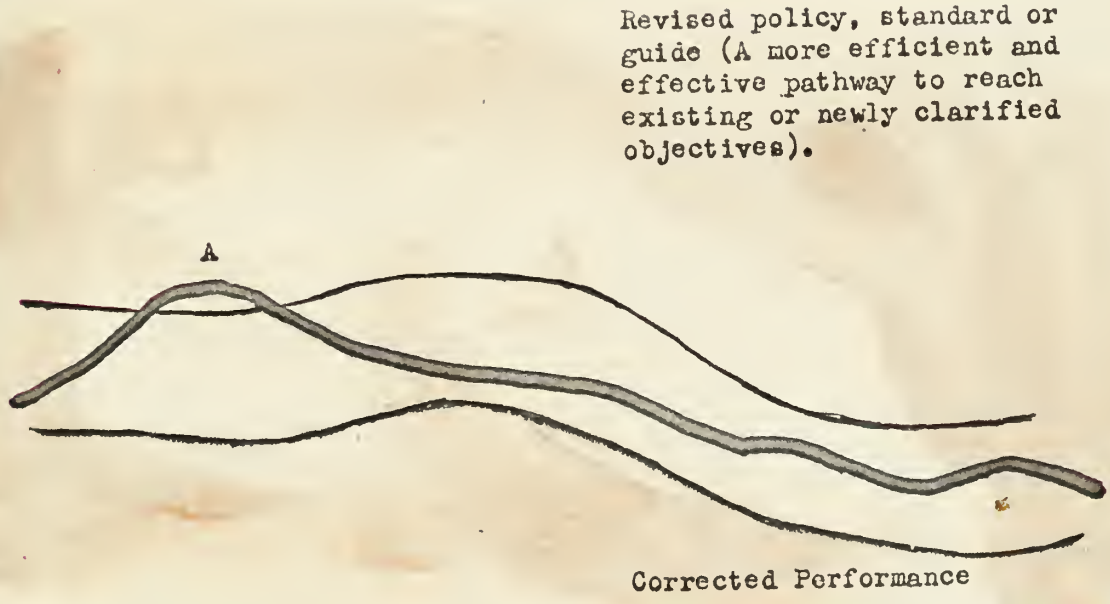
Revised policy, standard or guide (A more efficient and effective pathway to reach existing or newly clarified objectives).
A
Corrected Performance

Fig. 2-3.--Revision of policy or standard and correction of performance[a]

[a]Source: Dauten, Gammill, and Robinson, op. cit., p. 140.

Douglas Sherwin writing in Dun's Review and Modern Industry states "The essence of control is action which adjusts operations to predetermined standards, and its basis is information in the hands of managers."[1]

Sherwin goes on to say managers control adherence to the policies, plans, objectives, structure and procedures of the organization. Control is not concerned with establishing a system of internal checks (sometimes referred to as internal audit or internal control); this is a function of organization, which segregates the record-keeping and custodianship responsibilities and provides for a periodic reconciliation of the two. Whereas the system of internal checks is "built-in," "static," and "preventative," control is "active," "continual," "after-the-fact" and "corrective." The budget of an enterprise, likewise, is not a method of exercising control. It is related to control only in the sense that it is utilized as a basis for reporting progress against an approved plan. The other functions of the budget process, i.e., presenting objectives, plans and programs in financial terms and defining responsibilities and authority limits, are related to the planning and organizing activities.[2]

In addressing the question of who should exercise control, Sherwin concludes that the ultimate responsibility for control rests with the individual responsible for establishing the standards against which results are to be measured. Long-range planning and the approval of operating plans

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[1]Douglas S. Sherwin, "The Meaning of Control," Dun's Review and Modern Industry, January, 1956, p. 46.

[2]Ibid., p. 46.

are responsibilities of top management, hence, "ultimate control" must also rest high in the organizational structure. This is not to imply that control should be exercised exclusively at the top; but, rather, along with other authority and responsibility, should be delegated to the lowest practical organizational level so that it becomes a responsibility of subordinate managers to control the adherence of operations in the system they have established. Control is, therefore, a responsibility of all levels of management. Rather than a single set of controls serving all managers, Sherwin visualizes the control over specific operations and informational requirements of the controllers changing with some being added or relinquished at successive levels in the organizational structure. He describes it in this manner:

> . . . the process of fading out and shading in of information is continued as you move up the management pyramid until, just as in the visible spectrum the colors at one end are wholly unlike those at the other, the information reported to the top is wholly different from the information reported to first-line managers.[1]

Replacing the need for specific and detailed control information at the higher organizational level is the need for data which Sherwin refers to as "Information for Aiming and Planning." This two-part data flow is shown in figure 2-4, page 33. Although separate loops are indicated, the data flowing in both may at times be composed of similar elements. But because of the different purposes for which it is to be used, it is most often dissimilar -- each category of information being conceptually different and inappropriate to the other purpose.[2]

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[1] Ibid., p. 84.

[2] Ibid.

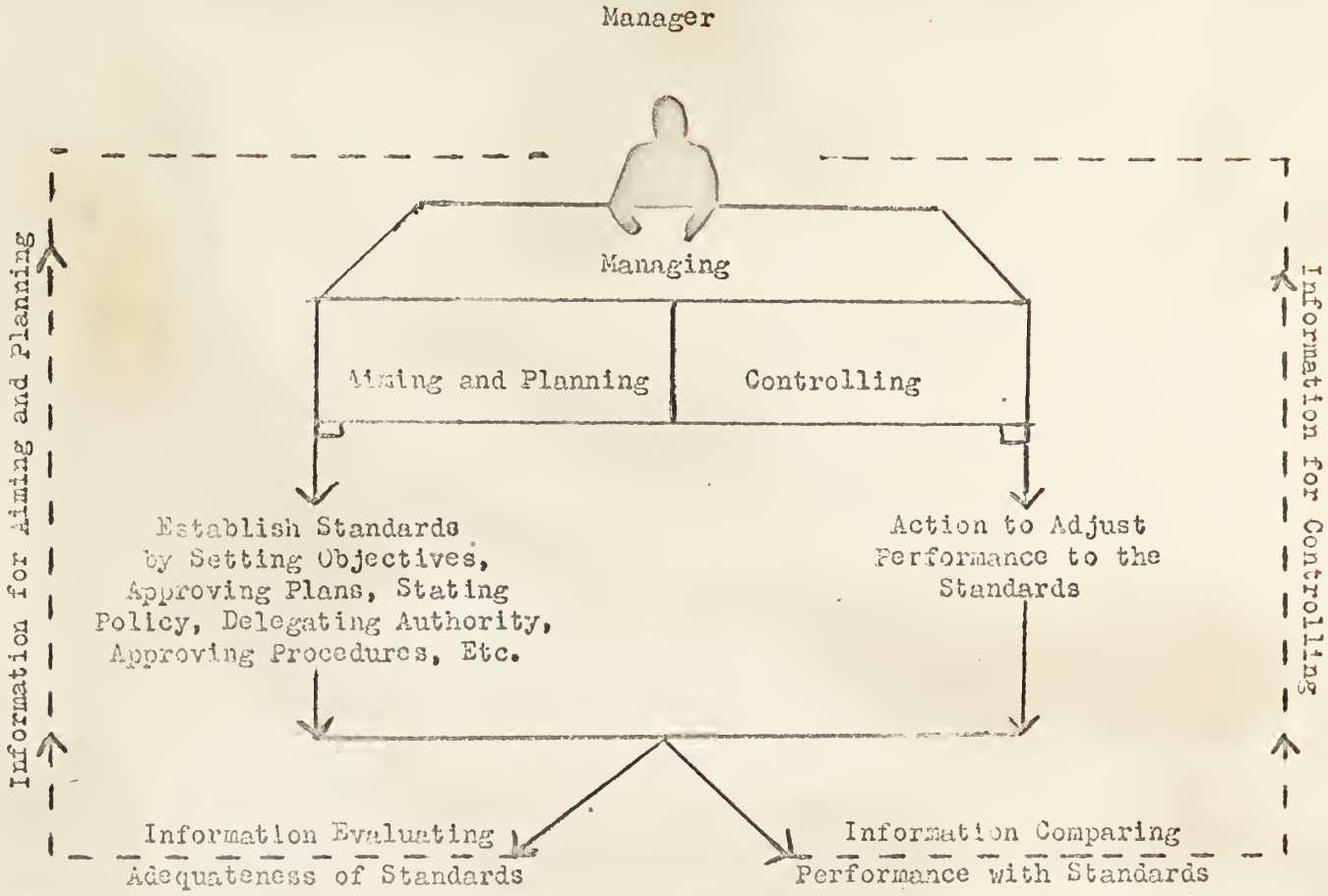
Manager
Managing
Aiming and Planning
Controlling
Information for Aiming and Planning
Information for Controlling
Establish Standards by Setting Objectives, Approving Plans, Stating Policy, Delegating Authority, Approving Procedures, Etc.
Action to Adjust Performance to the Standards
Information Evaluating Adequateness of Standards
Information Comparing Performance with Standards

Fig. 2-4.--A two-part management information flow[a]

[a]Source: Sherwin, op. cit., p. 45.

The Informational Aspects of Control

Arnold Emch, writing in the Harvard Business Review for July-August, 1954, observes the close relation between control and organization. The success of any plan of organization, according to Emch, is dependent upon the system of control which must be an integral part of it. In other words, an executive's ability to function effectively at any level is determined largely by the quality and kinds of information coming to him. Emch states it in this manner:

> We have a job to do -- a line of service or products to make and sell at a profit. There are a number of persons involved in the doing of that job. Hence, we organize ourselves in some fashion so that each one of us has specific, assigned tasks, all more or less related to one another. And we try to see that each key individual has a clear understanding of his functions, of his lines of authority downward, and his line of responsibility upward.
>
> But, if we should go only this far, we would not go far enough. We must also determine what each of these individuals needs in the way of facts and figures in order to perform his job effectively. This, then, is the problem of control: to match the responsibilities of every key position with the management information necessary for the effective and efficient execution of those responsibilities. Control itself can be defined as the making of decisions and taking of actions required by the responsibilities of each position, i.e., the proper performance of each executive according to the requirement of his position.
>
> Now, some readers may object to this concept on the ground that it does not even mention the familiar rudiments of control, traditionally conceived. You may be prompted to say: "Control means making sure that actual results conform to desired results, and this involves three basic functions: (a) setting standards of satisfactory performance; (b) checking results to see how they compare with the standards; and (c) taking corrective action where actual results do not meet the standards.
>
> I have no quarrel with this concept, except that these functions ought to be, and in fact must be, built into the organization structure as part and parcel of the responsibilities and authorities of every key position. They should not be segregated and put on a list of functions under the heading "control."

> This brings us to the basic flaw of most control systems as well as of most plans of organization. Control and organization have generally been treated independently of each other, thus missing the point of how the organization is to work in practice, or of what the executives are trying to control in the operations. Actually, organization and control are inseparable when there is effective management; they cannot function properly without each other.[1]

Nearly anyone in an organization receiving a well-designed, concise and clear report of operations compared with plan can discern deviations from the plan. Merely discovering unsatisfactory conditions, as Emch indicates, is not control. Control, which must be accomplished within the framework of organizational plans, involves action -- action to prevent deviations from plans and to correct errors.

Control action must be taken by those executives who have been delegated the authority and responsibility for the operations involved. It makes no sense, Emch elaborates, to assign a person specific responsibility for an operational area, including the goals associated therewith, and then through continuous "denials, restrictions, limitations, and specifications," inhibit his ability for appropriate response. If the "nominally responsible" manager does succeed under these circumstances, it is probably because of an almost super-human effort rather than because of the overriding decisions emanating from above. If, on the other hand, he fails, there is a question of who is responsible and therefore accountable for the failure. If an organization plan is to be of any value, it must show specifically who is responsible for the preventative or corrective action.[2]

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[1]Arnold F. Emch, "Control Means Action," Harvard Business Review, July-August, 1954, p. 94-95.

[2]Ibid., p. 97.

For most functions in large organizations direct observation is insufficient for the exercise of control. So a system of information, designed to meet the needs of responsible managers at all levels is required. While the information system does not need to follow the formal command channels of the organization chart, it must provide a flow of necessary data to all responsible executives identified in the plan. The flow of information must be both timely enough to be of genuine value in the exercise of control and adequate in terms of being neither too little nor too much. Emch believes a control system should require only what is "absolutely necessary" in the way of reports, data and statistics. He offers this maxim for executives to follow in determining what is absolutely necessary: "In accord with your responsibilities and authority, can you or should you do anything about the information that is presented to you and, if so, what?"[1] If the response is negative, the data in the hands of the recipient is something between purely informative and wholly useless -- it is not control data.

Ronald Daniel, a member of a well known management consulting firm finds there exists a widespread "management information crisis . . . not in the sense of there not being enough information, but in terms of relevancy for setting objectives, for shaping alternative strategies, for making decisions, and for measuring results against planned goals."[2]

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[1] Ibid., p. 98.

[2] D. Ronald Daniel, "Management Information Crisis," Harvard Business Review, September-October, 1961, p. 111.

This problem, according to Daniel, is caused by a gap between information systems which have remained static and organization structures which have undergone extensive changes. These changes have resulted in the creation of new positions, new responsibilities and the modification of patterns of authority, all of which have originated new requirements for information, both in substance and in distribution. Unfortunately, as Daniel observes, companies are suffering an information void -- "often without realizing it."[1]

The link between organization structure and information requirements is inseparable. Information is the media for translation of a statement of duties into action. The factual needs of large, widely diversified and expanding companies are immense and include data which is both financial and non-financial in character, and internal and external to the firm. It is often taken for granted, Daniel indicates, that to a large degree information necessary for a manager to perform his duties tends to flow naturally to the job. This is partially true in companies involved in only one industry group or that have small, well integrated management teams in which information systems are based on frequent face to face contacts, coordinating committees, frequent trade contacts and other less formal means. This type of information system may well serve the small or medium-sized enterprise. However, most large organizations, with extended communication channels and broad responsibilities for top managers, must rely more on formal methods of communications, and less on direct observation.[2]

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[1] Ibid., p. 112.

[2] Ibid.

The first step in designing a management information system, according to Daniel, is to determine each executive's information requirements based on: (a) his role in the organization, (b) his responsibilities and the authority he holds, and (c) his relationships with other members of the firm. On this basis, the procedural network should be established to convert both internally and externally derived raw data into information which is appropriate and usable at each executive position in the network. This approach requires a tailoring of the data, recognizing the specific needs of individual executives according to both their hierarchial location and intended use of the data. Specifically, Daniel emphasizes that information which is useful and desirable for long-range planning is far different from control data. This distinction is illustrated in figure 2-5 page 39, which categorizes the types of planning information as (1) environmental -- concerned with the setting in which the firm currently operates or can expect to operate in the future; (2) competitive -- dealing with the current position and plans of important rivals; and (3) internal -- indicating the firm's own strengths and weaknesses.[1]

Control data, although it also includes elements obtained from both external and internal sources, has quite different characteristics. Daniel emphasizes these contrasts between planning and control information:

> 1. Coverage -- Good planning information is not compartmentalized by functions. Indeed, it seeks to transcend the divisions that exist in a company and to provide the basis on which integrated plans can be made. In Contrast, control information hews closely to organizational lines so that it can be used to measure performance and help in holding specific managers more accountable.

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[1] Ibid., p. 113.

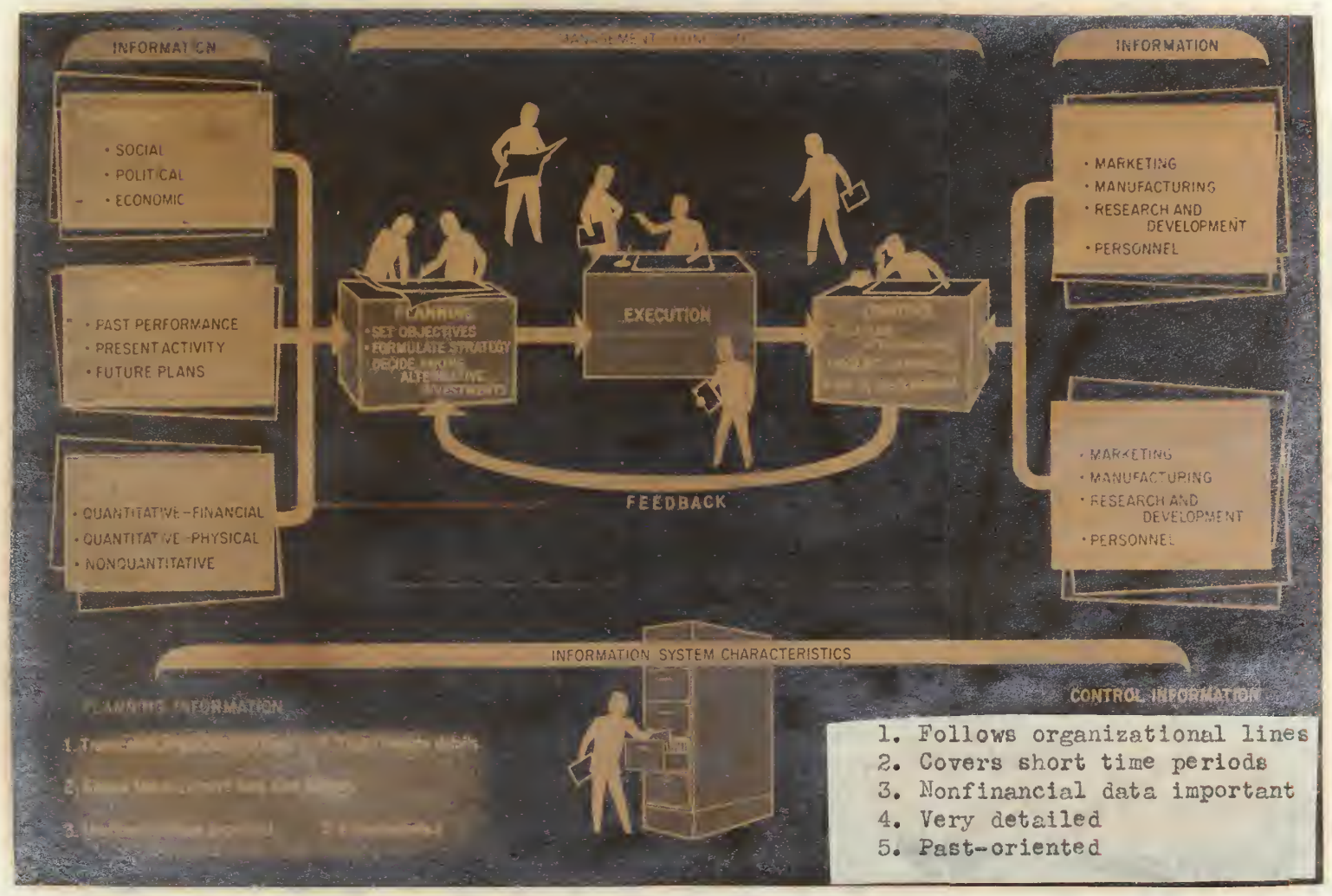

Fig. 2-5.--The anatomy of management information[a]

[a]Source: Daniel, op. cit., p. 114.

2. Length of time -- Planning information covers fairly long periods of time -- months and years rather than days and weeks -- and deals with trends. Thus, although it should be regularly prepared, it is not developed as frequently as control information.

3. Degree of detail -- Excessive detail is the quicksand of intelligent planning. Unlike control, where precision and minute care do have a place, planning (and particularly long-range planning) focuses on the major outlines of the situation ahead . . . .

4. Orientation -- Planning information should provide insights into the future. Control information shows past results and the reasons for them.[1]

Summary

Control in the management sense has found many meanings. Fayol's concept of insuring that events conform to plan through examination of results, finding weaknesses and errors and preventing their recurrence has, through the years, been expanded, modified, and redefined to become appropriate for describing nearly any activity a manager may perform. Because control involves intelligence gathering and analysis, some writers have found control to be the basis for management planning. A clearer insight into the nature of information and its relationship to executive responsibility has caused a wider realization of the considerable difference in the types and quantities of information required for the various management purposes. To a degree, this represents a return to the Fayolian concept of control. But management thought has tended never to remain static. After completion of the first full cycle there has been a renewed interest in the development of a multi-purpose informational flow within an organization

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[1] Ibid., pp. 117-119.

that will insure unity of purpose through management control, while at the same time it provides data for formulating long-range strategies appropriate to environmental conditions. This "holistic" approach to management theory emphasizes the interrelationship of activities within a total organizational "system" and shows how internal stability is achieved through the adequate flow of information to and from organizational control centers. This concept of an organization has its origins in the relatively new doctrines of management science which is the subject of the following chapter.

CHAPTER III

THE MANAGEMENT SCIENCE CONCEPT OF CONTROL IN ORGANIZATION

Lyndall Urwick at midpoint in World War II commented:

> At the moment there is admittedly, an insufficient basis in the physical sciences for an exact science of administration. The chief cause of the disaster under which humanity is at present suffering is a lack of balance between man's knowledge of the physical sciences and his grasp of the laws of social organization necessary to control the power which that knowledge has created.[1]

Ironically, it was precisely that global confrontation that gave stimulus to scientific research into administrative problems. This effort, in the words of Jay Forrester, a modern day management scientist, has brought management ". . . from an art, based only on experience, to a profession, based on an underlying structure of principles and science."[2]

The Origins of Management Science

Management science has been traced back to Charles Babbage, who in the early nineteenth century advocated a rational or "scientific" approach to production problems[3] or, more commonly, to Frederick W. Taylor

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[1]Urwick, The Elements . . ., op. cit., p. 8.

[2]Jay W. Forrester, Industrial Dynamics (Cambridge, Mass: M.I.T. Press, and New York: John Wiley & Sons, Inc., 1961), p. 1.

[3]Donald J. Clough, Concepts in Management Science (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1963), p. 16.

and his contemporaries in the scientific management movement.[1] In retrospect, however, these earlier efforts would appear to be more closely related to engineering than to an applied science. The beginning of the modern concepts of management science is usually identified with the efforts of a number of scientists during the early 1940's, both in this country and Great Britain, to solve military logistic and decision problems.

In the United States at this time, a group of scientists under Professor P. M. S. Blockett were engaged in performing analysis and developing data for decision-making regarding utilization of military resources. Although concerned initially only with the technical aspects, these inquiries led to what in essence were managerial problems. For example, Blockett's group studied "the radar interceptor defence system as an integrated man-machine system involving human, technological and operational management aspects."[2] In England, scientists were engaged in programming British fighter aircraft during the Battle of Britain, an effort which resulted in "unprecedented effectiveness with the limited resources of the RAF."[3]

At the close of World War II, the attention of the scientists was directed to the problems of management in commercial enterprise. Their wartime efforts had sharpened the scientists' insight into the decision

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[1]George Kozmetsky and Paul Kircher, Electronic Computers and Management Control (New York: McGraw-Hill Book Company, Inc., 1956), p. 121.

[2]Donald J. Clough, Concepts in Management Science (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1963), p. 26.

[3]Kozmetsky and Kircher, op. cit., p. 121.

process in the economic sphere and led to the realization that further investigation of this subject could be rewarding both to the scientists and to the managers who could directly benefit in terms of improved methodology. Prior to World War II, Kozmetsky and Kircher point out, managers tended to view their work as an art and scientists had little interests in business problems for it was not "professionally acceptable" for a scientist to work in commercial fields unless engaged in product research efforts.[1]

The early work of the management scientists indicated business problems to be far more complicated and hence more challenging than most scientists realized. During the war, for example, a group of scientists developed a highly effective search theory for the location of submarines. Subsequently they attempted, without success, to apply this theory to what was assumed to be the relatively "simple" problem of locating customers for retail sales operations.[2]

Management science has made a significant contribution to the practice of management. As is true of any worthwhile endeavor, it arose to fill a need. Clough has stated it in this way:

> Because of the size and complexity of modern organizations, administrative decisions often affect large numbers of people and enormous quantities of capital. The many interacting variables in a large operation are not generally amenable to quick-and-easy analysis, and in fact cannot always be identified explicitly. In addition, feedback on the results of many executive decisions is not available for months or years, so that trial and error judgements are usually costly and often completely meaningless. Management

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[1] Ibid., p. 121.

[2] Ibid., p. 137.

> science has grown out of efforts to develop decision-making criteria and operating strategies which are effective in the face of the increasing complexities and higher stakes of modern military and industrial operations.[1]

Operationally, management science can be defined as the application of the methodology, reasonings and sometimes the findings of other disciplines, including physics, chemistry, biology, physiology, economics, and experimental psychology, to the study of organization and organizational activities. Management science is inter-disciplinary in its approach. It has been said: "Management science uses what it needs and what is available to solve executive problems."[2]

The Methodology of Management Science

Management science as described by Kozmetsky and Kircher includes these technical steps:

1. Initial exploration of the problem and approximate formulation of the relationship between relevant factors.
2. Followed by a more precise identification and measurement of the factors involved.
3. More formal expression of the relationships between the factors and desired results, often by construction of a mathematical model.
4. Testing of the model to provide a basis for improved procedures, processes, decisions, etc. The resultant solution may be

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[1]Clough, op. cit., pp. 27-28.

[2]Ibid., p. 27.

> optimum or merely satisfactory or may instead indicate the manner in which the model can be improved to provide a more desirable result.[1]

In practice, this approach is not greatly dissimilar to the so called non-scientific, intuitive, or heuristic method of problem solving and in its application at times may be difficult to distinguish. In both, the problem is frequently subdivided into constituent, more manageable parts which are then solved or treated as if they were solved. The parts are then reassembled into a composite solution. The basic difference between the scientific and non-scientific approach however, is the extent to which the problem is defined and the manner in which it is defined and the way in which measurements and the relationships between parts are expressed, recombined and tested for validity.

The working model of the organization or a component thereof may be developed either through observation of the organization, its interrelated constituents and the environment in which it operates, or by application through analogous reasoning of the findings resulting from observation of similiarily constituted systems. The systems from which the analogies are drawn may be similar organizations or units or, as is frequently the case in the scientific approach to management, a parallelism is developed between phenomena which occur in the physical systems and in the economic and social realms.

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[1]Kozmetsky and Kircher, op. cit., p. 122.

[2]Ibid., p. 123.

Information-Feedback Control Theory

Information-Feedback Control Theory exemplifies abstraction of phenomena recognized in physical systems and their application to the management systems of human enterprise. This theory has had considerable impact in recent years in the design efforts for management information and control systems both in military and civilian organizations. The concept of information-feedback and control in human oriented systems had its origins in 1938 when a group of scientists from various disciplines began to meet at Harvard University to discuss common problems of control. The efforts of this group brought about renewed interest in von Bertalanffy's General System Theory[1] as the several different lines of thought, which these scientists had developed independently, were beginning to show common features. A natural unity was perceived in the design principles applicable to electronic controllers for machines, the mathematical expression of the behavior of information in electrical communication systems, and the flow of information in cerebral systems of higher animals.[2] Norbert Wiener, who was to become the catalyst for this effort, coined the word "Cybernetics" (from the Greek word "Kubernetes" meaning steersman or governor) to describe the entire field of communication and control theory as it is found in machines, higher animals and social and economic organizations.[3] The

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[1]Ludwig von Bertalanffy, "General System Theory," reprinted in General Systems Yearbook, Vol. I, 1956.

[2]Stafford Beer, Cybernetics and Management (New York: John Wiley & Sons, Inc., 1959), pp. 1-2.

[3]Norbert Wiener, The Human Use of Human Beings: Cybernetics and Society (2d ed. rev.; Garden City, N. Y.: Doubleday & Company, Inc., 1954), p. 15.

guiding principles of Cybernetics have been identified by Honomichi as these:

> Organic life can be approximated (if not explained) by mathematical reasoning.
>
> Communication and control are closely related.
>
> A better understanding of machines will help man to better understand organic life. Or, conversely, man can improve machines by imitating life processes.[1]

Control is thus perceived a necessary attribute of any viable system.[2] Systems, biological, psychological, social, economic and so on, remain viable through their ability to utilize feedback information to overcome ". . . nature's tendency toward disorder by adjusting its parts to various purposive ends."[3]

In general, a system in which feedback control is present will exhibit these characteristics:

1. The system will be subject to some "disturbing" influence.

2. A goal or desired state for the system can be defined. This may be either fixed or varied arbitrarily by a "goal-setting agent" possessing learning and computer capabilities.

3. Because of disturbing influences, the fluctuations of goals, or both, the actual state will not be the same as the desired state.[4]

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[1]Jack J. Honomichi, "Machines That Think Like Men," Management Review, September 1963, pp. 39-40.

[2]A system has been defined as ". . . anything that consists of parts connected together" (Beer, op. cit., p. 9.) or ". . . a collection of states together with the rules whereby they change" (Gordon Pask, An Approach to Cybernetics, Science Today Series, New York: Harper and Brothers, 1961, p. 115.

[3]Wiener, op. cit., p. 27.

[4]Clough, op. cit., p. 81.

Definitionally, feedback control is ". . . an operation which tends to reduce the difference, or the error between the desired state and the actual state."[1] This implies the error must be "sensed" or "measured" and used to automatically cause corrective action to be taken. Also implied in this definition is the axiom that the appropriate control action is determined by the magnitude of the error and the rate of change of the error.

Clough emphasizes the importance of timely control response, pointing out that in many systems there is an appreciable surveillance lag between the actual necessity for taking action and the point in time when that necessity is recognized by the "controller."[2]

The concept of feedback control in social systems is similar to the homeostasis tendency of living organisms and the control exercised by servo-mechanical devices in electro-mechanical systems. The thermostatically controlled heating system provides an excellent example of the operation of a feedback control mechanism in the physical world and by anology, a homeostat in any "naturally occurring" viable system.[3] The thermostat, heating device and enclosed space form a closed-loop control system in

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[1] Ibid., p. 81.

[2] Ibid.

[3] A homeostat is defined as "any of a general class of electro-magnetic, electro-chemical or electronic contrivances which effectively simulate the . . . maintenance of homeostasis by any viable physio-logical, biological, political, social, economic or other . . . systems." From: [Tentative Version] A Selected Glossary of Terms with Particular Reference to Concepts Associated with "Cybernetic Management" and the "Information Technology," an unpublished undated work by Dr. R. F. Ericson, Professor of Business Administration, The George Washington University.

which the heating device affects the temperature of the enclosed space and the thermostatic control device turns the furnace on or off whenever the temperature within the space reaches the threshold limits. The thermostat exercises control by comparing the actual performance, i.e., the amount of heat within the room with the desired state and transmitting a control message to the heating device.[1] The control message may direct the heater to turn-on or turn-off, or if performance is tending toward the desired range, to continue in its present status. After the desired range or "zero" variance has been achieved, control messages (which are a reflection of the variance) are no longer generated and, hence, information ceases to flow in the system. The thermostatic control system is described as "closed looped" or "closed cycle" as there is no direct sensing of the disturbing influences external to the system. These external influences, nevertheless, affect the ability of the system to achieve the desired state. To replace the thermostatic device with a human decision-maker does not alter the "closed-loopness" of the system; however, in this system the desired temperature range would not be explicit and held constant but, rather, would change because of the interaction of other uncontrolled variables with the controlled variable of temperature. The human decision-maker, in this case, would act not as a single sensor but as a number of sensors reacting to such variables as humidity, time of day, physical activity and psychological state, all of which interact in a complex way.

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[1]H. M. James, N. B. Nichols, and R. S. Phillips (eds.) Theory of Servomechanisms. (New York: McGraw-Hill Book Company, Inc., 1947), p. 62.

[2]Clough, op. cit., pp. 82-83.

In the thermostat or human controlled system there will usually be some overshooting of the desired range of temperature because of (a) the time lag between the output of heat and its actual delivery to the enclosed space, (b) the recognition of the temperature change by the controller and (c) the overall time required to elicit the directed response from the heating unit. It should be noted that the control message, because of the time delay involved, is based not on the heater output at that specific point in time but upon its previous output. The total delay in the system must be calculated from the time the accumulated heater output was sufficient to achieve the desired temperature range in the enclosed space. Feedback control or Cybernetic devices always cause a performance cycle of an amplitude and length governed by the characteristics of the feedback loop in the system.[1]

The Systems Concept of An Organization

The systems concept of an organization emerges more clearly when it is compared with the traditional, organization chart, model of the firm. Organization charts of the type shown in figure 3-1, page 52 are intended to depict formal relationships among people, processes or both. In figure 3-1 the heavy lines indicate the chain-of-command or communication channels connecting line processes; the lighter lines indicate the staff activities and altogether comprise the total line and staff complex. The chief limitation of this type of presentation is that it is unrealistic in the sense that it avoids recognition of informal communication channels which exist in all organizations and because it provides no clear insight as to

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[1]Joseph W. McGuire, Theories of Business Behavior (Englewood Cliffs: N. J.: Prentice-Hall, Inc., 1964), p. 24.

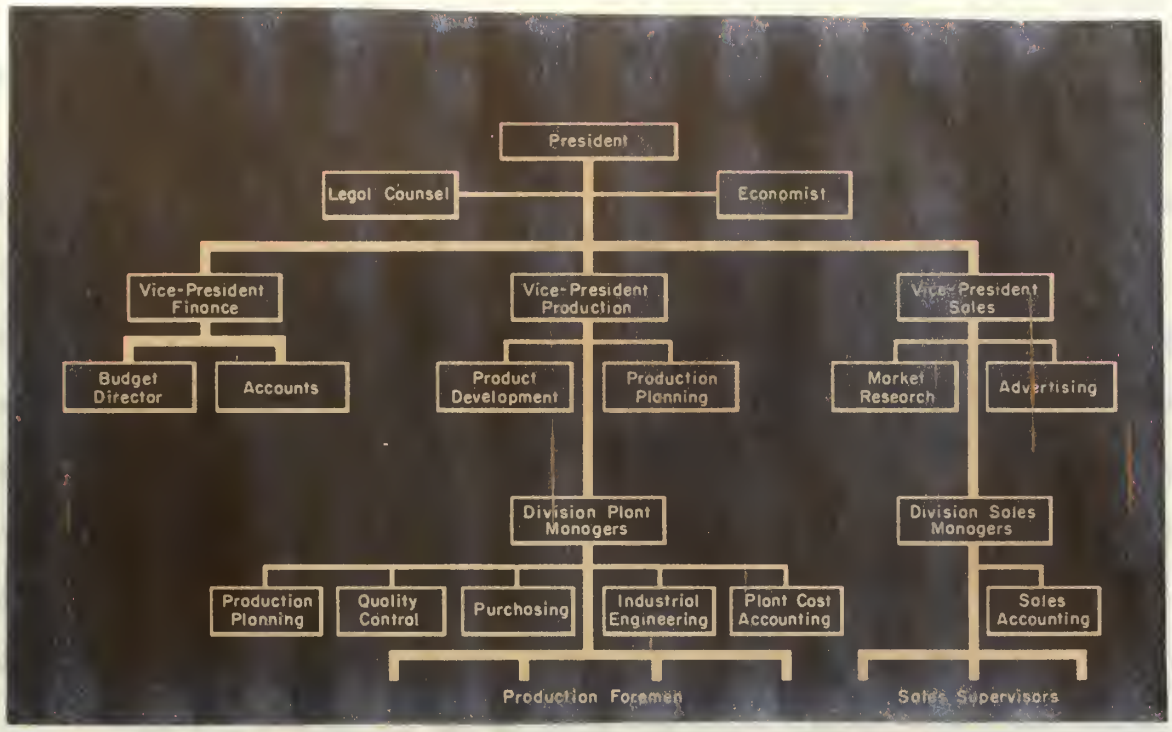

Fig. 3-1.--A simplified organization chart[a]

[a]Source: Clough, op. cit., p. 92.

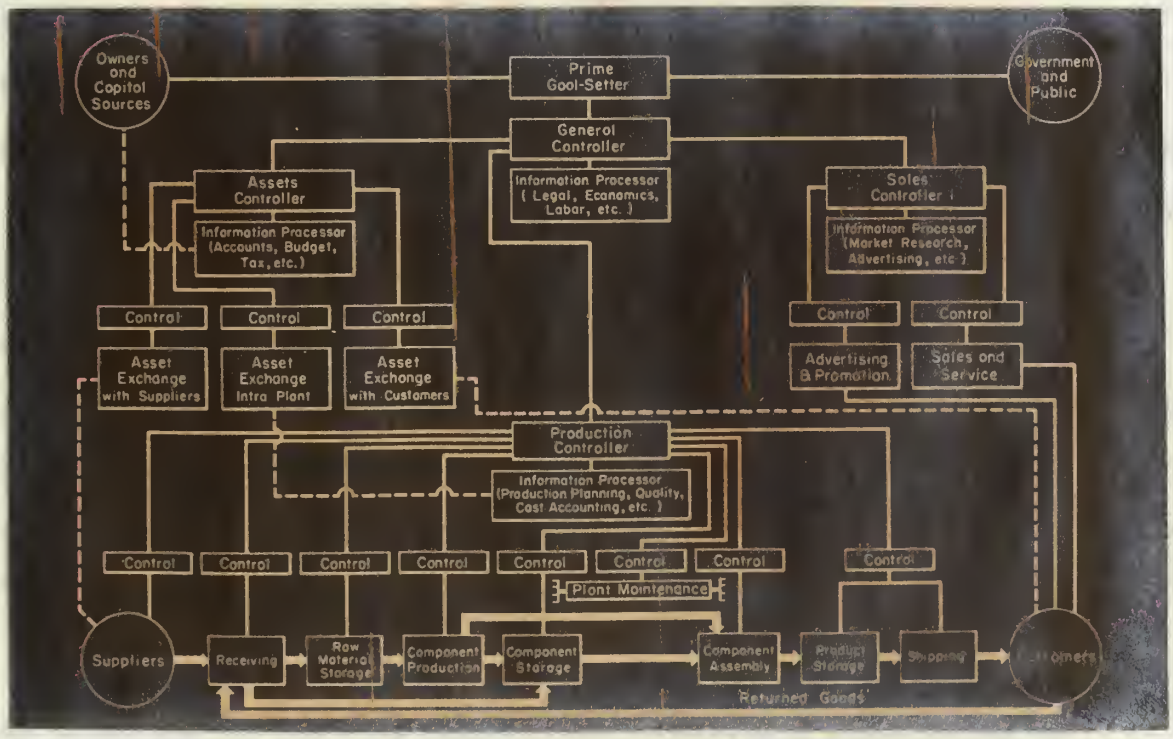

Fig. 3-2.--A simplified communications chart of an organization[a]

[a]Source: Clough, op. cit., p. 93.

how the communication process functions.[1]

The feedback control concept clarifies this relationship by depicting the organization as a system of financial, production and sales sub-systems (figure 3-2, page 52).[2] Input to the system consists of labor, orders, capital, materials of production and process information. The output consists of products and services. The disturbing influences include fluctuations in customer orders, market price of inputs, availability of material and labor and changes in labor and social pressure, government regulations etc. The system and its component sub-systems each include goal-setters, controllers, information-processors and sensors.

The goal-setter of the overall corporate entity, i.e., the Board of Directors, sets goals and objectives and receives from the controller (usually the President or General Manager) periodic reports on performance and changes in disturbing influences. The goal-setter determines the desired state of the system and, if satisfied that the control circuits will perform properly, permits the controller to freely act to achieve the desired state. The controller employs an information processor which may be his own brain or an extension of his brain -- a staff organization -- to decode and analyze messages and to process and encode communications to other parts of the system. The information-processor communicates directly with the controller but also maintains two-way communication with the controlled system and receives information from outside the system. Ideally,

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[1]Clough, op. cit., pp. 90-91.

[2]The material concerning the application of feedback control theory to organizations has been adapted from Clough, op. cit., pp. 85-90.

these communications should not be for the purpose of exercising direct control as this is an exclusive function of the controller. But, to facilitate information-processing and to permit the system components to obtain clarification of control messages and assistance in subsidiary decision-making, direct communication between the information-processor and subordinates is often permitted. Without the direct link between the staff and components, controllers would be unable to handle all the message traffic, some of which is relatively unimportant to the prime control function.

The sensors, who gather both internal and external information for the controller, may be subordinate line managers but, it should be recognized, these individuals may have goals which are in conflict with those of the formal organization and, when acting as sensors, may become "noise generators" or "information filters." This limitation is sometimes overcome by use of staff-assistants to the controller as sensors or by implementation of automated techniques for the sensing and reporting of control and environmental data.

The total organizational system, as indicated previously, is composed of many sub-systems governed by lower-order control circuits. There exists, therefore, a hierarchy of goal-setters, control loops within control loops and individual controllers functioning as goal-setters to the subordinate controllers. This scheme involves a complex chain of interrelated decision-makers who are continuously influencing and being influenced by the decisions of others. The strongest influence is exerted by the prime

goal-setter; however, information generated in the lower-order circuits also exerts considerable influence because it affects the "payoff estimates" and the choices of alternate plans by the higher-order goal setters.

The relationship of the system, sub-systems and environment is shown in figure 3-2, page 52 which depicts the flow of materials (heavy lines) from suppliers through the states of production to customers. Superimposed on the flow chart is the communication circuits utilized to control this process, (solid lines) which connect the goal-setters, controllers, information-processor and sensors who are a part of the high-order and low-order systems. A separate channel of cummunication (dotted lines) carries information to the assets controller regarding exchange of assets within the system. The separate circuit for assets data emphasizes that this information is not utilized to exercise control.

The study of an information feedback control system is, in actuality, a study of how information is used for planning and control purposes and demonstrates how the structure of the system, time delays and amplification may induce unstable fluctuations in system performance. Forrester describes these characteristics as they relate to behavior of mechanical, biological and social systems:

> The structure of a system tells how the parts are related to one another. Delays always exist in the availability of information, in making decisions based on the information, and in taking action on the decisions. Amplification usually exists throughout such systems, especially in the decision policies of our industrial and social systems. Amplification is manifested when an action is more forceful than might at first seem to be implied by the information inputs to the governing decisions.[1]

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[1]Jay W. Forrester, Industrial Dynamics (Cambridge, Mass.: M.I.T. Press, and New York: John Wiley & Sons, Inc., 1961), pp. 15-16.

Forrester advocates simulation, or experimentation with a mathematical model, to explain the effects of system structure, delays and amplification on the six basic flows in an industrial system -- information, money, customer orders, material, personnel and capital equipment -- and as a guide in system design and policy and procedure development. Experimentation is necessary because mathematical analysis has not reached a state whereby general analytical solutions can be achieved for problems as complex as those encountered in business.[1] Simulation also provides the framework for integrating the functional areas of the organization -- marketing, production, accounting, etc. This technique has great utility not only in systems development but, according to Forrester, also for unifying management education which currently is "highly fragmentized" and presented to the student "as a sequence of unrelated subjects."[2]

In this regard Forrester's thesis can be considered complementary to Fayol's. Both are concerned with the effective teaching of a management curriculum; both have focused on the integrating activities of chief executives of organizations who must bring together the contributions of the various functional areas into a common effort toward a common goal. Fayol's attention was directed to the task of identifying the methodology employed by the successful administrator. Forrester, conversely, considers the observation and recording of human experience in the arena of management to be of limited value in building a useful body of management thought.

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[1] Ibid., p. 17.

[2] Ibid., p. 2.

"As long as there is no orderly underlying scientific base," he maintains, "these experiences remain special cases. The lessons are poorly transferrable either in time or in space."[1] Lacking the mathematical tools to proceed from general concepts or "principles" of management as they have developed over the years to an analytical proof of their validity, management's scientific base must be developed through controlled experimental manipulation of the significant variables to determine satisfactory solutions to management problems. The electronic computer has made Forrester's "Industrial dynamics" simulation technique feasible.[2]

Summary

This chapter has covered only limited aspects of the rapidly expanding management science effort. Closely related to systems theory and simulation are the management science developments in decision theory, statistical sampling, probability theory, game theory and other aids to management decision-making.

The considerable emphasis given in management science to information-feedback and control in organizations has been to some extent, a natural outgrowth of the rapidly expanding technology of information handling brought about by the introduction in the last decade of the electronic business computer and the implementation of the revolutionary, new decision tools which allow the automation of certain "routine" decisional processes

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[1] Ibid., p. 2.

[2] Ibid., p. 18.

as well as the consideration of additional data inputs and relationships in complex, non-routine, decision-making.

Management scientists and the management traditionalists will agree that effective planning, the establishment of realistic and measurable goals and the efficient communication and utilization of information are requisites for management control. Not all will agree, however, with the management scientists' concepts of the organizational system or that information-feedback control theory adequately describes the management process. Jerome, for example, considers the concepts of cybernetics and the theory of servomechanisms appropriate for machines and some shop processes but "too rigid for the world of people."[1]

System theory, however, is helpful in gaining an understanding of the processes which occur in human organizations, since it is easier to study structurally analogous but simpler systems and generalize from the less complex to the more complex. This approach is valid provided the analogies are well founded and generalization is not carried too far.[2] The systems approach is used as the basis for a discussion of design considerations applicable to management information and control systems in the next chapter of this paper.

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[1]Jerome, op. cit., pp. 31-32.

[2]William G. Scott, Human Relations in Management: A Behavioral Science Approach (Homewood, Ill.: Richard D. Irwin, Inc., 1962), p. 151.

CHAPTER IV

SOME CONSIDERATIONS IN THE DESIGN OF MANAGEMENT INFORMATION AND CONTROL SYSTEMS

Information in some form is the basis for all managerial actions. Information received by an executive and enriched by his own ideas and experiences leads to the formulation of policy and plans of action and to their implementation. As plans become operational, information provides a basis for replanning and for the prevention and correction of deviations. In the past, managers have often found their decisions to be less accurate than they had expected, or not implemented as timely and effectively as they had expected because the information which they had been provided was inaccurate, lacked completeness or was excessively slow.[1] With equipments currently available for the manipulation, storage and communication of data, it is technically feasible to develop an information system that will provide an array of reports that is timely, accurate and appropriate for all centers of managerial planning and control in even the largest and most complex organizations.[2]

All organizations have a management information system. It may consist of any number of combinations of word-of-mouth reporting, accounting

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[1]James D. Gallagher, Management Information Systems and the Computer A.M.A. Research Study No. 51, (New York: American Management Association, 1961), p. 7.

[2]Ibid., p. 11.

records and reports, memoranda, meetings, conferences, and regular and non-recurring statistical and narrative reports prepared manually or with electro-mechanical equipments. In large organizations, because of the complexity and variety of the problems faced, an electronic computer may be installed to handle advanced statistical computations involving large quantities of "raw data" and to facilitate the storage, retreval and transmission of data within the organization. The ability to handle large amounts of data and to report this information rapidly throughout the organization does not in itself assure an improved management information system.[1]

Electronic data processing, with its capacity to produce vast amounts of information, in actuality, can be a disservice to managements. Unless business computers are properly utilized and incorporated into a well designed information system, executives in search of the necessary data to carry out their responsibilities "may be forced to ingest and digest reams of general purpose information not especially designed for any specific management job."[2] Gallagher considers the most important aspect of data processing to be the proper selection, arrangement and distribution of management information. Yet, he finds:

> Despite all the advances in data processing, a breakdown in the . . . preparation of managerial planning and control reports and their proper utilization . . . is all too frequently observed. The underlying reason is that not only the systems planners who design data-processing programs but also those who actually manage the systems often prove to be unaware of the exact needs of management for clear and continuing reports on the total course of a business. When this kind of failure occurs, the usual course of data-processing personnel is to take refuge in the preparation of

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[1] Ibid., pp. 12-13.

[2] F. W. Cannon, "Project Inter-Loc," Data Processing for Management, June, 1964, p. 33.

> data reports; the expensive and complex data-processing equipment is used almost exclusively for "electronic record keeping" and the preparation for management of tabulated reports which are in fact only the results of consolidating "raw data" records without reference to the real needs of management.[1]

Previous chapters of this paper have briefly covered the traditional approach to management control and the management science concept of information and control. In this chapter both contributions will be considered in their application to the design of management information and control systems.[2] The terms "management information and control systems" and "integrated business systems" are frequently used interchangably. Both refer to integrated information systems, usually computer based, which combine the various data sub-systems -- production, scheduling, purchasing, inventory and others -- into a unified system serving the whole of management.[3] An integrated system has also been described as a company-wide linking of the events which originate information with those events which occur "whenever and wherever someone uses the information."[4]

The systems approach to management information and control emphasizes the existence of sub-systems for the sensing of management data and the exercising of control and their innerconnection to form a single high-order system which serves and is served by all parts of the organization. The systems view is highly useful in that it depicts the interrelationships of

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[1]Gallagher, op. cit., p. 13.

[2]To some extent the term "management information and control systems" is redundant. Information is the basis for and effects implementation of control and, of course, a control system carries information. The term is useful, however, because it does emphasize the two-fold purpose of the system which is to carry information for both planning and controlling.

[3]Gallagher, op. cit., p. 115.

[4]Kozmetsky and Kircher, op. cit., p. 169.

the various operational processes which, as Forrester points out, "will often be more important than the separate components themselves."[1] Too often there is a tendency to focus on the functional or specialized activities of an organization rather than on the unified effort required to achieve the organizational goals. Peter Drucker has discussed this problem in an article on long-range planning. "There is, after all," he stresses, "no functional profit, no functional loss, no functional investment, no functional risk . . . ."[2]

Conversely, there is danger in the "holistic" view of management of overlooking the desirable qualities inherent in non-integrated, functionally oriented information and control systems, of failing to note the highly important differences in the information requirements of the various goal setters and controllers and of giving inadequate consideration to the related question of the appropriate location of control centers within the organization. These aspects of system design will be considered in the balance of this chapter through an interfacing of recent writings on the subject of management information and control systems with the traditional and management science concepts presented in earlier chapters.

Measurement of Information and Control System Performance

As has been noted previously, the too heavy emphasis on functional efficiency may hinder the achievement of over-all organizational goals.

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[1]Forrester, op. cit., p. 6.

[2]Peter F. Drucker, "Long-Range Planning, Challenge to Management Science," Management Science, April, 1959, p. 247.

Charles Stein, Jr., has commented on this problem:

> In a truly integrated management information system, the basic inputs will be combined, changed in form, merged, consolidated, and analyzed so that the information needs of every level of management are met in a timely, accurate, and useful fashion with minimal duplication of input data. The interrelationships of the various functions and operations will be so accurately reflected that every decision . . . will optimize over-all company goals rather than those of any particular part or function . . . .
>
> The ability of the truly integrated information system to portray the overall operations in their relationships to company objectives can have a significant effect on the traditional concepts of organization . . . . The tasks required to carry out the operations of a business are divided among several functional suborganizations . . . .
>
> Each of these functional units either is given or develops its own objectives. The inventory manager, for example, may have the objective of keeping his inventory levels as low as possible; the traffic manager may seek to move everything by means of the cheapest . . . delivery requirements; the production manager may want long manufacturing runs with a minimum of engineering changes; the engineer may want to change the product every time a good idea comes along; and the sales force may want large finished-good inventories and rapid deliveries so that customer orders can be filled promptly.
>
> These functional objectives make it very difficult for top management to determine what is good for the company as a whole . . . .
>
> Thus the best decision for the over-all operation may require what appears to the functional managers to be unnecessary expenditures for transportation, warehouse space, or inventory investment.[1]

Robert Gordon emphasized this approach requires that two commonly held impressions persisting in management today be overcome:

> A total information system, I would like the reader to infer, is for the company first, and for its subordinate parts last. The implications of this rather simple-sounding view are considerable for

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[1]Charles Stein, Jr., The Changing Dimensions of Office Management, A. M. A. Management Report No. 41, (New York: American Management Association, 1961), pp. 83-84.

> it contradicts two very widely and tenaciously held notions: (1) that the whole is nothing more than the sum of its parts; and (2) that what is good for a division or a department must inevitably be good for the company as a whole.[1]

As Sherwin[2] has indicated an organizational element has only delegated rights to the information it does possess. The development of a system for the gathering of the data essential for managers to carry out their responsibilities is an arduous task, occurring over an extended period of time for as, Ronald Daniel[3] has indicated, necessary information does not flow naturally to the job. This information has in time, become tailored to its specific application and to the source inputs available. Information sub-systems tend to perform quite adequately for their intended purpose. The information gap develops, Daniel also points out, when the organization structure is changed. New positions, responsibilities and authority relationships can be decreed into effect; however such facility is not usually experienced when attempting to modify an information system that has grown, quite informally, over time. What is often not recognized is the considerable ingenuity and genuine utility of these informal gathering operations. Thompson states this point well in discussing military information systems:

> . . . the emphasis today on information systems built around computers and communication equipment has obscured the great informational efficiencies obtained by other means. This is particularly true of military information-processing systems. The military command hierarchy, with its already highly developed information traditions,

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[1]Robert M. Gordon, Data Processing Today: A Progress Report, A. M. A. Management Report No. 46, (New York: American Management Association, 1960), p. 26.

[2]Supra, pp. 30-32.

[3]Supra, pp. 36-40.

> has provided means of reaching levels of information-processing efficiency that are difficult to contemplate fully. These efficiencies, embodied in organizations, should not be subject to deprivation. And, although these traditions in themselves are no longer adequate for solving the severe informational problems of the military, they are an important part of its foundations and must be understood, improved, and strengthened, not ignored and replaced.[1]

Daniel has cited the need for formal methods of communication, particularly in large and changing organizations. He also emphasizes the need for external information by an organization operating in a changing environment. It is, however, the external information that is often the most difficult to gather and report in a systemized, formal manner. Outside events, for example the events which produce sales, often elude measurement until it is too late for their use in controlling.[2] The results of these events, i.e., daily, weekly or monthly sales, are measurable but often lack significance or worse yet may mislead, if not considered in relation to the available information concerning the event(s) which produced them. Weekly narrative reports from company salesmen are time consuming to prepare and digest and a strong inclination may exist to replace this seemingly inefficient method of communication by more complete, more detailed statistical reports of sales by product line, customer, territory, size, color, price line and so forth. This greater emphasis on the results of the events rather than on the less quantifiable causes of these events may in actuality result in less control.

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[1]Frederick B. Thompson, "Design Fundamentals of Military Information Systems," Military Information Systems: The Design of Computer Aided Systems for Command ed. Edward Bennett, James Degan and Joseph Spiegal, (New York: Frederick A. Praeger, Inc., 1964), p. 47.

[2]Peter F. Drucker, "Controls, Control and Management," Management Controls: New Directions in Basic Research, ed. Charles P. Bonini, Robert K. Jaedicke, and Harvey M. Wagener, (New York: McGraw-Hill Book Company, 1964), pp. 285-294.

Peter Drucker discusses the problem of measurements, and quantifiable and non-quantifiable events in his description of the four major characteristics of control systems in business enterprises:[1]

1. Although the measurement of a physical event is objective and numerical, the measure of a social event is subjective and biased. To single out a social event to be controlled signals the importance of the event and has the effect of both changing the event and the perception of the observer. Thus controls in human organizations become goal-setting and value setting themselves by giving meaning and importance to the event. Scrap losses, Drucker points out, in themselves are significant to the firm only for their indirect effect on profits. Yet to single out scrap loss as an item to be controlled establishes the attainment of a low scrap loss as a goal for the responsible manager and a set of values upon which his performance can be judged. Overattention to the scrap situation obviously can cause disproportionate expense in other less controlled areas.

2. In most enterprises ninety per cent of the volume results from two to five per cent of the items. Similarly, ninety per cent of the incurred costs result from less than ten per cent of the events. Management therefore needs a system of controls which correctly identifies the real structure of an event. Drucker states: "In fact . . . the constant drift towards the irrelevant and unproductive is so great, and the weight behind it so heavy, that a 'controls' system which did nothing but focus attention on the central events -- the events which under normal probability statistics are not seen at all -- would give any manager a great deal more control and

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[1]Drucker, "Controls, . . ." op. cit., pp. 285-294.

very much better performance and results than the most elaborate simulation and quantification can possibly produce."[1]

3. Businesses are institutions of society and exist to contribute to society. Consequently the results of enterprise, according to Drucker exist only outside the business. It is the customer who creates a "profit;" the events that occur within only create costs.[2] Yet, Drucker observes, managements have only limited ability to measure outside events and this is the area in which information and control systems can make their greatest contributions. Paradoxically, most of the data sensing and control effort has been directed to internal events which are the easiest to measure and control rather than to external events where the effort can be the most productive.

4. "Business unlike all natural and mechanical systems exhibits a wide range of events and results that are of profound importance and yet cannot easily be quantified within any meaningful system of measurement. But business, also, unlike any other social system has a wide range of events and results which can be quantified. Business is the only system we know which has both quantifiable and non-quantifiable results and events, both equally important."[3]

"This gives a unique opportunity for "control" and also a unique problem . . . . Measurements which do not spell out the assumptions in

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[1] Ibid., p. 291.

[2] Ibid., p. 292.

[3] Ibid., p. 294.

respect to the non-measurable elements involved misdirect and misinform."[1]

Drucker goes on to say that as more management information is expressed quantitatively the greater will be the temptation to emphasize these measures of performance and the greater the danger that what appears to be "better control" will actually result in "less control" or the business being "out of control."[2]

The necessity for adequate means of measure or appropriate standards must also apply to the information and control system itself. An undefined notion that modification and integration of seemingly inefficient information and control systems into a superordinate-system serving the entire firm will produce better information and better control is insufficient reason to disrupt a currently functioning system. That the whole is greater than the sum of the parts must be proven specifically in each case. More information is often erroneously equated with better information[3] more control with better control.[4] A realistic standard must therefore be established to indicate the qualitative improvement that may be expected from any contemplated revision of current data gathering and reporting techniques and control procedures.

There are, of course, no universal set of factors that can be applied to determine the effectiveness of a management information system. What

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[1]Ibid., p. 294.

[2]Ibid.

[3]S. A. Spencer, "The Dark at the Top of the Stairs: What Higher Management Needs From Information Systems," Management Review, July 1962, p. 6.

[4]Drucker, "Controls, . . ." op. cit., p. 286.

may be important to one organization may be relatively unimportant to another. The specific factors in evaluating a specific system depend upon the objectives of the organization, the strategies available for the achievement of these objectives and the rapidity with which these strategies will change. Effectiveness measures are also important to determine a cost/benefits ratio for any additional investment required to support the contemplated change. It has been said: "The complexity of current information systems is such that some of the design objectives cannot be explicitly stated; however, evaluation must be in terms of what can be stated explicitly and decisions made only in terms of these objectives rather than in terms of general inprovements expected in the system or the performance of the organization served by it."[1]

The Information and Control Spectrum

Evans and Hague State:

> In order to work out a rational, integrated information system, it is essential that information requirements of all levels of the organization be considered. Those of the shop foreman, naturally, will not be the same as those of the president. And the manager of manufacturing needs information that varies considerably from that used by the productive worker at a machine . . .
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> . . . . . .
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> Once information output requirements are determined, attention should be concentrated on information input requirements. The objective here is twofold: (a) to keep information inputs to a minimum, and (b) to devise ways of generating these inputs in elemental forms most convenient for direct processing into as many of the required output documents as possible.[2]

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[1]Ruth M. Davis, "Military Information Systems Design Techniques," Military Information Systems: The Design of Computer Aided Systems for Command ed. Edward Bennett, James Degan and Joseph Spiegal, (New York: Frederick A. Praeger, Inc., 1964), p. 20.

[2]Marshall K. Evans and Lou R. Hague, "Master Plan for Information Systems," Harvard Business Review, January-February, 1962, p. 95.

Most writers on the subject of information and control point out the variform information requirements of managers. Daniel states information must be tailored to the hierarchical position and intended purpose of the potential user. Koontz[1] stresses that what is meaningful to one manager may not be to another. Jerome[2] contends that control should provide managers with the information to specifically plan and evaluate their own performance. However, tailoring of information is not analogous to reworking the same data by summarizing, condensing, consolidating, reporting in a different foremat, converting from statistical to graphic presentation and so on. Both Daniel and Sherwin have indicated that planning information may be composed of the same data elements as control information but usually is not.

A clearer image of the informational requirements and control responsibilities of individual managers emerges from the three part analysis of the managerial function put forth by Norman Ream[3] and more recently that propounded by John Dearden.[4] The management task, according to these authors, is embodied in these activities:

1. Strategic Planning, which consists of (a) determining corporate policies and objectives; (b) deciding on any changes in these policies and objectives and (c) deciding on the resources to be devoted to attaining these objectives.

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[1]Supra, pp. 21-23.

[2]Supra, pp. 26-27.

[3]Norman J. Ream, "The Need for Compact Management Intelligence," Management Control Systems, ed. Donald G. Malcolm and Alan J. Rowe (New York: John Wiley & Sons, Inc., 1960), pp. 82-94.

[4]John Dearden, "Can Management Information Be Automated?" Harvard Business Review, March-April, 1964, pp. 128-135.

2. Management Control, which consists of (a) dividing the strategic plans into logical subdivisions; (b) providing the funds to carry out the subdivisions of the plans; (c) assigning the responsibility for carrying out each plan to some individual; (d) following-up to see that the assignment is being satisfactorily carried out.

3. Operational Control, which consists of (a) determining the specific men, equipment, material and information necessary to accomplish the subdivision of the plan; (b) assigning those resources so that the plan can be carried out in the most efficient manner; and (c) comparing actual result with plans and taking corrective action when appropriate.[1]

All levels of management may be concerned to some degree with all of these activities. As Ream Points Out:

> . . . we find that the responsibility for management planning and management control increases as we approach the top echelons of management, and that operational control receives its greatest emphasis at the . . . lowest management level. It is recognized, of course, that planning and control responsibilities are inherent in every level of management. The basic distinction lies in the emphasis on the nature and degree of the planning and operational control responsibilities found at each distinct level of management.[2]

For most purposes management control can be thought of as "supervising and evaluating operational personnel" and operational control as "carrying out the day-to-day operations of the business."[3] Viewed in this manner some essential difference in the types of data required for each of these forms of control is readily seen. For example, notification that the "on-hand" quantity of a particular item of stock has decreased to a pre-established "low limit" or "tolerance threshold" may be quite necessary

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[1] Ibid., pp. 129-130.

[2] Ream, op. cit., p. 90.

[3] Dearden, op. cit., p. 130.

in the exercise of operational control but would be of little importance in management control, even less in strategic planning. Although there may be isolated requirements for stock level data elsewhere in the organization, i.e., in the sales and production departments possibly, to report this information throughout the organization makes no sense at all. Similiarly, much of the long-range planning data would be of little value in the solution of today's problems.

Charles Stein, Jr. speaks of the "spectrum of decision" occurring in a management system:

> I have heard many people say that there are really two parts to a management system: (1) the routine tasks which do not involve any decision making, and (2) the decisions involved in planning and controlling operations. For our . . . purposes, however, it is more useful to regard the entire process as a "spectrum of decision." At the lower end of the spectrum are the simple, routine decisions . . . . Toward the middle of the spectrum are the more complex but still fundamentally "mechanical" decisions . . . . At the upper end of the spectrum are the extremely complex managerial decisions . . . . As we move up the spectrum more and more human judgement is injected into the decisions.[1]

There exists also as Sherwin has affirmed a spectrum of information and control, with some being added or relinquished at each successive level. Dauten, Gammill and Robinson[2] visualize the "control reading" as an indication that action is required to correct a deviation in performance or to adjust the established goals. But different forms of information are required for each task. Although information used for one level of decision-making may be restructured and inputed to another decision level it is important to note that not all information has such wide utility. Therefore a body of information gathered by the sensors of inside and outside events

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[1]Stein, op. cit., pp. 82-83.

[2]Supra, pp. 27-30.

should flow through the system whereas other data should be transmitted directly to the particular sub-system or decision level which can utilize it. This is a fact not to be overlooked in systems design. Dearden has observed a common mistake in many Management Information Systems in that information is provided to one level that has been developed for use at another. Inappropriately directed information is not only meaningless and time wasting to the recipient but it tends to obscure the fact that many decisions must be made without all the necessary information.[1]

Control, as the term is used by Jerome in slightly different context, represents "patterns of activity followed by the skilled executive in order to achieve some mastery over his environment."[2] The environment of the goal-setter is often appreciably different from that of the controller. There must be, as Emch insists,[3] a complimentary relationship between control and organization, between flow of information and responsibility. The importance of these relationships must not become obscured by overemphasis of the holistic view of management and corresponding lesser attention to its constituent parts.

Locus of Control

In the previous section emphasis was placed on the need for consideration of the information requirements of the various managers in the organization. The problem of furnishing appropriate information, assuming the data is available somewhere in the corporate entity, is a function of

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[1]Dearden, op. cit., p. 134.

[2]Jerome, op. cit., p. 34.

[3]Supra, pp. 32-36.

the number of non-similar informational requirements which exist in the organization. Implicit in most systems design objectives is the notion of efficiency through less departmentalization and fewer levels of management and hence fewer specialized information requirements and fewer data element inputs and outputs. More explicit expression of this supposition is contained in the predictions of some observers that control of vast organizational complexes will, in the near future, be centralized in "management cockpits" which are envisioned to be essentially computer equipped decision-making rooms with elaborate display devices, including cathode ray and light gun consoles. In these surroundings sales managers, controllers, treasurers and production managers, rather than managing functional processes from separate offices or divisions will operate as a team to analyze and direct the integrated effort of the organization by application of the same decision rules and watching the same scoreboard for total results.[1]

Achievement of the "management cockpit" type of control envisions the realization of an over-all, fully integrated, or "total" management system with complete monitoring of the enterprise by a computer or group of interconnected computers and automated control of machines, inventories, production, shipments, accounting, payrolls and all other operations that can be represented mathematically. Direct human intervention would be limited to "goal setting" and reaction to totally unexpected disturbances brought on by wars, acts of God and so forth.[2]

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[1]James M. Ewell, "The Total Systems Concept and How To Organize For It," Computers and Automation, September 1961, p. 9.

[2]Herbert E. Klein, "Computer in the Boardroom," Dun's Review and Modern Industry, September, 1964, p. 103.

Herbert Klein, however, points out that experts in the field of datamation do not agree on how close industry can come to a computer based total system because of disagreement on the machine's ability to react to many of the more common but as yet unpredictable situations. These individuals do agree, however that a system to provide top management "almost up to the second information on every aspect of the integrated business system" is feasible.[1] Computers, in the opinion of many authorities, have made recentralization of authority possible. One writer has stated: "Probably the most dramatic effect of automation is reversal of the trend to decentralization that became the fashion after World War II with each major division being operated almost like a separate company. Now companies . . . are using computers to allow more central decision-making and control.[2]

John Dearden is among those who demurs on the feasibility of total systems management by computer, at least for the foreseeable future. Although decision rules can be programmed into operational control systems, Dearden does not see how this can be accomplished in management control systems. Computers can make routine decisions but management decisions, he states, are usually not routine and, given the present state of the art, are not adaptable to automation. The type of instantaneous information that could be obtained from the boardroom or "management cockpit" computer would be either historical data, which normally need not be produced on short order, or operational control data. Operational control data, however are neither meaningful nor useful at a point so far removed from the

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[1] Ibid., p. 134a.

[2] Ibid., p. 139.

scene of operations. The danger inherent in this type of information system, according to Dearden, is that with top management attempting to control operations, either directly or through the continuing harassment of operating personnel, no one will be adequately performing the strategic planning and management control of the organization. A computer is not required to communicate when something is seriously wrong in the operations area, and this, he states, is the only time top management should be concerned. Although top executives may need some data daily, such as sales and production volume, the amount is not large and the usual procedure of passing this information up from operating managers, who are also concerned, can work quite satisfactorily.[1] Dearden's view of the distinction between management control and operational control is quite similar to Fayol's separation of management control and technical control. Fayol as well speaks of the potential danger of the infiltration of management control into the operations of the various departments.[2]

The determination of the appropriate organizational location for control is governed largely by the state of the art both in the generation of suitable informational input, and in its utilization and less by the technology of the communication and manipulation of data. Elements to be considered in the location of control centers in an organization are: the inherent communication delays in information and control systems; the problem of contextual adjustment in communication; and, the need for maintaining organizational flexibility.

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[1]Dearden, op. cit., pp. 128-135.

[2]Supra, p. 6.

Inherent Communication Delays in Information and Control Systems

Recent advances in the design of data processing equipments have resulted in phenomenal increases in the speed of access and manipulation of data. Random access memory devices and optimal programming techniques have reduced the transfer and computational time to a small fraction of that required a few short years ago. Similar developments in the telecommunication of data, both intra-plant and over thousands of miles have also occurred. Information systems are often viewed in terms of data processing; that is, Jacobs points out, as systems which transmit and manipulate "numbers or quantitative indicators of qualities relevant to conditions and action." Actually, Jacobs continues, "these systems are primarily concerned with the transmission and processing of concepts."[1]

Concepts are highly useful to those involved in the communication process. This can be illustrated by consideration of the various concepts which may be held concerning an item of production equipment, for example, a drill press in a non-automated process shop. The drill press operator is likely to view it as a machine which will drill holes to a pre-determined depth in steel and other materials at a rate of speed which is dependent upon the hardness of the material to be processed, the sharpness of the drill bit, and the revolutions per minute of the drill bit. To a mechanic,

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[1]John F. Jacobs, "Communication in the Design of Military Information Systems" Military Information Systems: The Design of Computer Aided Systems for Command, ed. Edward Bennett, James Degan and Joseph Spiegal, (New York: Frederick A. Praeger, Inc., 1964), pp. 31-32.

the drill press consists of a motor, drive belt, gear linkage and other parts some of which can be expected occasionally to require maintenance. To the manager of the production department the drill press might represent a stage in the production process, and a piece of equipment to be manned and for which work is to be scheduled. Each of these individuals, because of time and interest limitations, tends to hold to only those concept dimensions which are useful or necessary in his own job. Messages passing through information and control systems involve the translation of concepts, their co-ordination with previously held concepts, the embedding of new concepts, and the maintenance of previously held concepts to prevent distortion by newly translated and embedded concepts. This is the principal cause of communication difficulties in information and control systems and is one of the main reasons for time delays. To communicate, concepts must be translated into a "common vocabulary" which, in turn, may require many messages before true understanding is achieved.[1] Communication delays are often attributed to delays in handling of messages in the information system, however, Jacobs maintains, ". . . in comparison to the delays involved in the translation, embedding and maintenance of concepts, these delays are so short that they are, in most instances, trivial."[2]

The greater the distance (organizationally and physically) between the controller of an event and the implementer and sensor of that event, the greater the conceptual difference that each will attach to the event.[3]

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[1] Jacobs, op. cit., pp. 32-33.

[2] Ibid., p. 34.

[3] The truth of this statement is not altered by the use of an inanimate sensor which forms no concept of the event which it senses.

Returning to the previous example, if the production manager wishes to control directly the operations performed by the drill press operator, he must possess a concept of the production process that is sufficiently broad so as to include that which is held by the operator. Only in the smallest of organizations would this be feasible because of the time required to devote to the process of translation, embedding and maintenance of concepts.

Dauten, Gammill and Robinson show graphically as has Forrester in the book Industrial Dynamics the oscillations that can occur as a result in delays in the implementation of control response.[1] The element of timeliness is also included in the preventative aspects of control as put forth by Koontz, Allen and Jerome.[2] It is significant to note that many of the writers on the subject of control, including Forrester, discuss the problem of improving the timeliness of communication of data in terms of speeding up the processing of data through, or circumvention of, the intervening layers and interpretation points. The traditional approach has been largely to consider that the disadvantage of delay in upward reporting was partially offset by efficiencies achieved through the consolidation of data. For those cases involving an operational control of process in which speed of reaction to control information is of prime importance, traditionalists advocate assignment of control responsibilities to an individual close to the point of operations. It has only been with

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[1] Supra, pp. 28, 30 and 55.

[2] Supra, pp. 20-26.

the advent of the electronic computer and the capability to transmit rapidly large quantities of data over great distances that the considerable distinction between the transmission of data and the communication of concepts has begun to emerge. Shannon and Weaver[1] categorize the problems of communications as consisting of three levels:

Level A -- The technical problem -- How accurately can the symbols of communication be transmitted?

Level B -- The semantic problem -- How precisely do the transmitted symbols convey the desired meaning?

Level C -- The effectiveness problem -- How effectively does the received meaning affect conduct in the desired way?

The technical problem has been largely solved; only slight progress has been achieved at levels B and C. Thus, the time delays resulting from the problem of communicating concepts will remain for the foreseeable future, a significant consideration in information and control system design.

The Problem of Contextual Adjustment in Communication

According to cyberneticians, it is through the communication of information that a system is enabled to overcome the entropian tendency toward lack of structure and inertness. Within any system, however, there must exist a balance between the stability of the environment and the inertias of the informational process.[2] Thompson suggests that two ways in

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[1]Claude E. Shannon and Warren Weaver, The Mathematical Theory of Communication (Urbana: The University of Illinois Press, 1949), p. 96.

[2]Thompson, op. cit., p. 61.

which stability in a system is accomplished are "specilization" which imposes contextual restraint limiting the area of concern, and "abstraction" which limits the complexity of the context by grouping otherwise unrelated aspects of context as a single object.[1]

Within low order sub-systems (or organizational sub-units) the environment is highly specialized and characterized by confined interest. Moving up the system structure the specialties are merged to an expanded interest. The structure itself thus provides a means for overcoming the informational inertia and achieving efficiency within an information system. Specialization allows a sub-system to function with less informational input, and abstraction permits use of lower density messages for the integration of sub-systems into larger systems.[2]

Although it is theoretically possible to perform the contextual adjustment centrally within the organization, there are, according to Thompson, compelling reasons not to do so. ". . . the very essence of the efficiencies that the command hierarchy provides is its ability to hold information orders of greater magnitude than can be maintained in a single context."[3] This is evident when the "cryptic" messages of a football huddle are considered. For example, if the quarterback announces "Play number four, left end wide," far more meaning is conveyed than would be

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[1] Ibid.

[2] Ibid.

[3] Ibid., p. 64.

implied in the dictionary meanings of the words.[1] This is analogous to the situation occurring continuously in the business world whereby a one sentence directive from the manager of production, for example, to order a new item into production can set off a chain of events whereby the context of this single message is expanded and reexpanded by contextual adjustment into what may be hundreds of specific operational instructions all of which are necessary to achieve directed action. Although the entire set of detailed sub-instructions could be issued centrally rather than progressively throughout the organization, to do so would cause both an increase of message traffic in the information and control system and a sharp drop-off in the amount of information flowing in the system. The predicament is similar if control data is not adjusted contextually when reported to higher organizational levels:

> Imagine a situation in which a greater and greater amount of the context of the lower level is transmitted upward. At [sic] this amount begins to approximate the total context of the lower level, the communication processes themselves become an increasing portion of this context. Thus there comes a point at which the transmission of contextual aspects relevant to matters to the community becomes less than the transmission of matter concerning the communications themselves.[2]

To a degree the problem of information transfer without contextual adjustment is technical, but in its larger aspect it is concerned with the communication of relevancy. The denotation of the degree of importance assigned to data is an item of information that may be as important to the

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[1] Ibid., p. 65.

[2] Ibid., pp. 64-65.

recipient as the data elements themselves. Relevancy is also expressed by the choice of what is communicated. Thompson states: "The choice of facts communicated and the choice of facts asked not only determine the substantive content; they indicate what is thought to be revelant."[1]

The problem of contextual adjustment as it relates to the appropriate location for the exercise of control involves the ability of the information system to adapt the data to a form that it is meaningful to the recipient and will elicit the required response. This is again not a technical problem but rather it is related to the semantic and effectiveness problems identified by Shannon and Weaver. Jerome has indicated that control simplifies communications by providing a common language for quantitative matters. This is of course true if the quantitative language employed is meaningful to the recipient and its relevance to those matters which are his responsibility is apparent. The problem of communicating relevancy is related to the so called exception principle of reporting and controlling which is identified by Koontz. If properly employed the exception technique is an effective means not only of reducing the overall flow of data in the information and control system but of indicating the relevancy of what is entered into the system. This implies an initial screening of the control data and the selection of those elements which are relevant to the next level of authority. In Figure 2-1, page 28 Dauten, Gammill and Robinson show a deviation of little significance at point A and deviation at point B of a magnitude that warrants investigation.

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[1] Ibid.,p. 66.

The information and control system must, by contextual adjustment, indicate what is and what is not important to the control center. It is only when the information and control system provides this capability that the control center can be effectively separated from the point of action. It is in relation to the current limitations of many data handling systems, particularly automated systems, to pre-select and properly identify significant information that has led Allen to conclude the "greatest potential for control is in most cases, at the point of action."[1]

The Need for Maintaining Organizational Flexibility

Standards (or norms of performance) provide a common frame of reference -- they make the world more predictable. In this respect, Bennett states, they facilitate "inter-and intrasystem information-processing" and make communication and control more reliable. By the integration of standards into an information system, a manager can control a large number of sub-systems and by "symbolic manipulation," with or without the use of electronic computers, can design the strategies to accomplish his objectives. Standards, however, involve pre-determined parameters and thus impose constraints upon the range of actions a manager can take and the number of alternatives he can consider, thereby reducing his flexibility.[2]

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[1]Allen, op. cit., p. 319.

[2]Edward Bennett, "Flexibility of Military Information Systems," Military Information Systems: The Design of Computer Aided Systems for Command, ed. Edward Bennett, James Degan and Joseph Spiegal (New York: Frederick A. Praeger, Inc., 1964), pp. 97-98.

In lower-order systems, Bennett goes on to say, problems tend to be relatively well structured and the alternatives and the consequences can be predicted reasonably well, hence inflexibility is less of a problem. The operational drawbacks of a rigid and formalized system become most apparent at the higher levels of the organization. Integrated data processing systems require standardized procedures for the selection, consolidating, processing and presentation of data. In implementing these systems, some of the flexibility that was previously available to managers at all levels is sacrificed. The decision to computerize certain processes is not therefore exclusively a question of whether the computer can economically perform the task but also it is a question of whether it is desirable to rigidly specify and standardize the informational process involved.[1]

One of the chief advantages of the decentralization of control in an organization is that it allows the system to operate with a minimum of horizontal integration and standardization. At any level, Bennett points out, there may be various information processing activities; some are concerned with the appropriate response to data about the external environment and others with information concerning the internal organization or with special data about financial conditions, personnel, inventories, sales and so forth. These information activities need not be highly related since the amount of coordination that is required is determined by the requirements of the next level upward in the organization. Individual procedures can be developed for each of the functions without standardiza-

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[1] Ibid., p. 102.

tion of format, language or reporting procedures since they all come together at the next level upward and any subsequent reporting of this information can be done in consolidated summary form.[1]

When viewed from the top downward, organizational policies, as Clough[2] indicates, serve as guidelines for the free and appropriate response of subordinate controllers. Normally an individual at one level will instruct those immediately below him concerning what they are to accomplish by specification of the program objectives and it is for the subordinates to then perform the job in the appropriate manner consistent with the limits of regulations as set or interpreted by their superior. This procedure is designed to insure that the implementing action of subordinate controllers is oriented to over-all policy objectives while at the same time it permits maximum flexibility in the action to be taken at each level of response.[3]

In contrast to this, a centralized control system "triggers" a program by a single set of inputs from above. These inputs must specify in detail, by a rigid set of specifications of allowable actions, all the lower-order responses. Central control is therefore feasible only when:

(a) All the consequences of the controlled actions can be foreseen and preplanned.

(b) Corrective action will occur in sufficient time to preclude the occurrence of undesirable or unforeseen results.

(c) The system can readily adjust to new goals.

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[1] Ibid., pp. 106-107.

[2] Supra, p. 53.

[3] Ibid., p. 104.

For those events which cannot be subject to this type of control, Bennett concludes the focus of control should be placed at the level which will best permit the appropriate flexible response. He states: "In general, the optimum amount of centralization for any information system appears to be the minimum required for passing upward data summaries of actions taken at lower levels and data input inappropriate for action at those levels."[1]

Beyond this, he finds centralization tends to increase the data loads at the higher levels of the organization and tends to restrict the range of activities at lower levels, thereby decreasing the effectiveness of an executive's control over his resources.

Lack of flexibility would be one of the "unsought consequences" included in Koontz's second principle of control.[2] Emch and Jerome also discuss the need for flexible response by subordinates within a control system.[3]

Thompson has indicated the dichotomy that often exists in the design objectives for management information and control systems. By providing adequate information to top management on the results achieved by subordinate managers the information and control system is intended to provide the means whereby the decentralization of discretionary authority is made practicable. Yet the imposition of rigid standards and procedures, including uniform reporting techniques, may result in far less discretionary authority at the lower levels.

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[1] Ibid., p. 108.

[2] Koontz, "Management Control . . . ," op. cit., p. 51.

[3] Supra, pp. 26-36.

The flexibility of an enterprise is largely determined by its plan of organization. If authority and control responsibility is concentrated at too few organizational levels, the adaptability of the organization will be greatly curtailed. There is a direct relationship between the location of control centers within the organization and the ability of the organization to vary rapidly its response pattern to meet unexpected challenges and opportunities.

Summary

This chapter has considered certain of the more significant design considerations which have begun to emerge in recently published literature concerning management information and control systems. These writings indicate a recognition of certain limitations to the achievement of totally integrated systems which have come into view in the attempts to implement advanced technologies in data handling. Yet a review of the traditional literature of management control indicates a similar awareness of these problems.

The objectives of integrated management information and control systems are to provide to each executive in an organization data that is in usable quantity and is appropriate to the responsibilities of his position. The integrated system pre-supposes there will be a free-flow of information through the artificial and arbitrary functional and sub-organizational barriers existing in all large scale organizations so that all data imputed in the organizational "memory" will be readily available to all who require it. Integrated, computer based business systems and automated production processes make possible the accumulation of by-product data

concurrent with the on-going processes which have generated it. These systems also permit the rapid combining, merging, consolidating and otherwise manipulating of this data and its near instantaneous transmission to any point in the organization irrespective of the geographical distance involved. This capability together with the availability of the management scientist's decision aids -- simulation, decision theory, game theory, etc., -- has caused managements to reassess decentralization policies and to view the exercise of more direct control by top management as a means of achieving improved integration of all activities of the enterprise. To a large extent this appears to be at least an implied goal in the design of many of the management information and control systems currently being installed.[1]

This objective, however, pre-supposes a level of communication capability which has yet to be achieved in integrated data handling systems -- an ability to communicate concepts over extended organizational distance efficiently, an ability to select effectively the relevant facts to be transmitted to indicate this relevance in the communication process, and finally an ability to structure and appropriately report this data throughout the organization. To the extent that decision-making authority can be delegated to the machine these become technical problems and matters of decisional delay and overload at the decision centers are of less concern than in a man-machine system. However, as Forrester indicates, mathematical techniques have not yet reached a level that permits solution by formula of

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[1]Dearden, op. cit., p. 128.

the ill-structured, multivariable problems which are the substance of most managerial control decisions.[1]

In the process of designing systems with a greater degree of closed-loop control there is developing a realization that some of the previously utilized non-integrated functionally oriented management information and control systems which reflect the traditional concepts of information reporting and control have utility and purpose and a level of efficiency which is "difficult to contemplate fully."[2] These traditional systems often relied heavily on interpretative reporting of events and their probable causes rather than on a quantitative measure of the external manifestation of these events. This form of intelligence gathering, while ill-suited to many of the highly structured operational control problems of organizations, remains superior to statistical measure for many of the planning and management control responsibilities. Excellent progress to date has been made in the generation and reporting of operational by-product data. However, this data is not interchangeable with interpretative reporting of events and their causes. For these reasons management information and control systems planning should provide for an explicit measure of expected performance. Unclear assertions of potential improvements in speed, accuracy, completeness and appropriateness of reporting and control activities are insufficient to adjudge integrated data handling procedures to be superior to those currently in use.

Lyndall Urwick first suggested the use of control data in the planning process.[3] Those concerned with the formulation of the "principles" of

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[1] Supra, p. 56.

[2] Thompson, op. cit., p. 47.

[3] Urwick, The Elements . . . , op. cit., p. 102.

control have also emphasized the use of control data as a basis for forecasting and planning as well as for preventing and correcting deviations and errors. To a degree the management theorists who have stressed the action phase of management control have also recognized a close relationship between control and the other executive functions. The presence of control, according to Jerome,[1] creates an environment in which efforts of all the members in an organization are directed to the effective accomplishment of the goals and objectives. Dauten, Gammill and Robinson[2] visualize the exercise of control as leading to either the correction of deviations from plans or to replanning and subsequent implementation of newly formed or modified plans.

In some respects this view of control is not wholly unrelated to Mary Parker Follette's[3] concept of control through coordination in that the results rather than the methodology of control are stressed. Unlike Follette however, both Dauten and Jerome recognize reporting as the basis for control.

It has been, however, the "Informationists" who have perceived the great contrast in the types of information suitable for planning purposes as opposed to the data appropriate to the preventative or corrective actions of managers who are responsible for insuring that on-going operations conform to established goals. Sherwin[4] conceptualized the

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[1] Supra, pp. 26-27.

[2] Supra, pp. 27-29.

[3] Supra, pp. 11-13.

[4] Supra, pp. 31-33.

"control spectrum" to emphasize the differing informational requirements of various organizational levels and purposes. Emch[1] and Daniel[2] stress the importance of relating information flow to organizational assignment and judging the adequacy of information by appropriateness of its content and quantity in relation to the planning and control responsibilities of those who will receive it.

There is strong evidence in his writing that Fayol recognized the clear distinctions in the types of information required for planning, management control and technical control of operations. A number of subsequent writers on the subject of management control lost sight of these distinctions. However more recent contributors -- e.g., Sherwin, Daniel and others -- through emphasis on the informational aspects of control have shown a return to Fayol's view. This reemphasis of the distinct informational requirements for planning, managerial control and for operational control has developed largely as a result of the research of management scientists who have provided a better understanding of the nature of information and of feedback control in systems and organizations as well as a more precise vocabulary to describe this aspect of management.

There is a basic unity of purpose in the efforts of the traditional and the management science schools. Also there are complimentary aspects in the contributions both have made in the field of management. It has been predicted that through feedback, mutual enrichment and reinforcement,

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[1] Supra, pp. 34-37.

[2] Supra, pp. 27-30.

the significant contributions of both schools can ultimately merge into a unified body of management theory.[1]

The need for a generally accepted theoretical base for the management process has been often stressed. Fayol accredited the lack of management teaching in the technical schools to the need for a theory of management since, as he said, "without theory no teaching is possible."[2] Chester Barnard also decried the lack of "an acceptable conceptual scheme" by which executives could exchange ideas concerning their work.[3] Efforts to achieve a unified theory of management, or of any significant aspect of the management process, have been notably unsuccessful. Urwick's attempt to consolidate several of the early contributions in the field of management into a single "logical scheme" failed for the reasons cited earlier in this paper. Nor is there any evidence that the several attempts of Harold Koontz to build a unified theory based on management principles were any more fruitful.[4] Koontz attributes the difficulties in achieving a generally acceptable theory of management to a lack of a standard terminology and clear definition of management as well as a tendency of modern writers to discredit the

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[1]Koontz, Toward a . . ., op. cit., p. 15.

[2]Fayol, op. cit., pp. 14-15.

[3]Barnard, op. cit., p. 289.

[4]Harold Koontz, "A Preliminary Statement of Principles of Planning and Control," Current Issues and Emerging Concepts in Management: Readings for the Academy of Management, ed. Paul M. Dauten, Jr. (Boston: Houghton Mifflin Company, 1962), pp. 116-135.

Koontz, "Management Control . . .," op. cit., p. 56.

Koontz, Toward . . ., op. cit., p. 11.

contributions of others while offering, instead, what they believe are distinct and original approaches to management theory with which they will become identified.[1]

The problem involved is that any general theory of management must be stated in terms of generalizations because the number of variables in management situations and their complex interrelationships are not only difficult to perceive but defy mathematical or logical analysis and are thus incapable of proof. This is true whether the theory is based on the empirical observations and experience of the management traditionalist or the experimentation of the management scientist.[2] That generalizations cannot be proved, however, does not negate their usefulness, Beveridge explains:

> They [generalizations] can be tested by seeing whether deductions made from them are in accord with experimental and observational facts, and if the results are not as predicted, the hypothesis or generalization may be disproved. But a favorable result does not prove the generalization, because the deductions made from it may be true without its being true . . . . In strict logic a generalization is never proved and remains on probation indefinitely, but if it survives all attempts at disproof, it is accepted in practice, especially if it fits into a wider theoretical scheme.[3]

So long as management generalizations remain unprovable, new concepts of management and of the organization in which the management process occurs will continue to have their detractors, whether these concepts are based on observation and experience or are developed by analogy or simula-

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[1] Ibid., pp. 1-17.

[2] Forrester, op. cit., p. 18.

[3] W. I. B. Beveridge, The Art of Scientific Investigation (The Modern Library; New York: Random House, 1957), p. 118.

tion or other experimental means. Therefore a unified or generally accepted theory of management control is not likely to evolve, at least in the foreseeable future.

The distance currently separating the traditional and management science schools is perhaps characterized by these comments:

> Herbert Simon (in a discussion of the value of the traditional approach to management theory): "What you are saying about Fayol is that I ought to believe Fayol because he ran some coal mines, or whatever it was that he ran, very well. I see no reason to conclude from this that he is a man who can state propositions of organization theory that will stand up under the tests of evidence."[1]
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> Peter Drucker (in a paper dealing with the contributions of management science in the design of information and control systems): "What is needed . . . in the people who design controls is an ability different from that of the physical scientist and instrument maker."[2]

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[1] Koontz, Toward . . ., op. cit., p. 110.

[2] Drucker, "Controls, . . ., op. cit., pp. 295-296.

CHAPTER V

SUMMARY AND CONCLUSIONS

The research undertaken in the preparation of this paper has led this writer to the conclusion that traditional concepts of management control provide a useful body of knowledge which should be considered in conjunction with the contribution of management science in the design of management information and control systems.

The considerable utility of traditional management thought is not always fully evident, however. One reason is that the contributions of academicians and practitioners of management exhibit considerable disarray -- a condition particularly notable in the case of management control theory.

Control was first identified as an essential element of the management process by Henri Fayol, a French industrialist who devoted the latter years of his life to publishing a theory of management which he developed both from his personal observation and long experience. Fayol's theory of management was first published in France in 1916, under the title of Administration industrielle et générale; it was subsequently translated and published in English in 1929 and 1949. Management control, according to Fayol, involved insuring that events occur in conformance with plans by examining results, pointing out weaknesses and errors, rectifying them and preventing reoccurrence. He contrasted management control as exercised

by the top management of an organization with control exercised within the subordinate functional spheres of responsibility and spoke of the potential danger of management control infiltrating into the operations of the various departments.

Confusion concerning the exact meaning of management control has existed since the first translation of Fayol's work into English and continues to some degree, to the present time. Contributing causes include:

1. Failure of Fayol to complete Part III of his work, in which he planned to include an expanded explanation of his elements of management, including illustrative examples.

2. Inexactness in the translation of Fayol's work, which resulted in the use of the emotionally charged word "control" for his sixth element of management rather than a word bearing the connotation of checking, verifying or comparing which would be more appropriate to his intended meaning.

3. An early attempt by Lyndall Urwick to fit a number of independently developed and somewhat unrelated management concepts into a single "logical scheme" of management principles, processes and effects which produced an association of his idea that command results in control with Fayol's checking-up or surveillance aspect of management and Follette's concept of effecting control through coordination rather than coercion.

Goodwin finds Coubourgh, the first translator of Fayol's work, as primarily responsible for the confusion surrounding management control but Urwick must share in the blame as his book The Elements of Administration preceded the more widely distributed second translation of Fayol's work and had the effect of pre-conditioning readers to an erroneous interpretation.

Since that time control has taken on many meanings in connection with management -- from a very broad interpretation so as to become almost synonymous with "management" to restricted meanings such as "quality control" and "production control." Not only was Fayol's distinction between management control and technical control lost, but control came to include all intelligence gathering processes including the assembly of information for forecasting and planning as well as for the prevention of deviations and the correction of errors. More recent literature reflecting the traditional approaches to management control, however, has stressed the informational aspects of control -- claiming that information furnished to each executive in an organization must be appropriate to his specific responsibilities and that there are significant differences in the types of information suitable for strategic planning, for management control and for operational control. Although persons associated with the traditional school of management thought have, for the most part, avoided explicit recognition of the contributions of the management science school, the timing of their reemphasis of the relation of information and control would indicate the theory of control in organizations developed by the management scientists has had notable influence on traditional management thought.

The renewed stress on the distinct information requirements and executive responsibility associated with operational control, management control and strategic planning represents a return to the Fayolian concept. But, as is true of any worthwhile theory, management theory has been subject to continuing forces of change. Paradoxically, the formulation of a theory

of information-feedback control in human organizations which has led to a greater recognition by the traditionalists of the differentiation in informational requirements has led others to a "holistic" view of organizations, stressing the essential unity of informational requirements, responsibilities and objectives rather than differentiation. That two seemingly conflicting conclusions could be reached from examination of the nature and utilization of information within a humanly constituted organization is not necessarily indicative of erroneous reasoning by either group. Rather, it is indicative of the degree of acceptance of information-feedback control as an adequate explanation of the management process.

Information-Feedback Control Theory conceptualizes the management process as primarily effected through the flow of information in the organizational system and its constituent sub-systems. Objectives, expressed as a "desired state" for the system and sub-systems, are established by the goal-setter and communicated to the controller who is responsible, on the basis of information gathered by "sensors" and passed to him by "information processors" for correcting deviations from the desired state through feedback of directive information to the point of operations, in much the same manner as a thermostat controls a furnace or a servo-mechanism controls a machine. Unlike a thermostat which only senses data within an enclosed space, organizational sensors gather both internal information and external information related to the disturbing influences affecting the systems and sub-systems to be used, when necessary, for adjusting goals to more attainable levels. There will, however, always be delays and amplification in

an information-feedback control system resulting in oscillations between the actual and desired state of the system of an amplitude and length determined by the characteristics of the feedback loop. The search for means of overcoming this deficiency in organizational systems has led the management scientist to investigate the structure of organizations and the decision processes which occur within them and to simulate with mathematical models to determine improved organizational design.

Strategic planning, including the integration of the sub-systems, is effected by utilization of information flowing freely and rapidly throughout the organization, a feat considered technically feasible with the electronic data processing and data communications equipment currently available. This capability together with the new decision-aids developed by the management scientists has caused managements to consider recentralization as a means of reducing the effects on over-all performance caused by deviations from plan (oscillations) within organizational sub-units and to place greater reliance on quantitative measures of events rather than on qualitative expressions or subjective analysis of these events. In addition integrated computer based management information and control systems are being designed to replace functionally oriented systems.

The achievement of these objectives, however, requires a level of communication capability yet to be achieved in integrated automated data handling systems. Specifically these would include the ability to (a) efficiently communicate concepts over extended organizational distances, (b) effectively measure the causes of events, to select relevant facts and

to indicate this relevance in the communication process and to provide information that is appropriate in type, quantity and foremat to each responsible manager within an organization and (c) maintain flexibility in a centrally activated information and control system.

There is ample evidence in the traditional literature of management control of a recognition of these problems in the exercise of control within organizations as well as the fact that a trade-off exists in the exchange of functionally oriented control for integrated control. This admonitory advice concerning control, it must be acknowledged, is often obscured in inpreciseness of terminology and clouded by vague generalities and contradictions which have caused its depredation by those oriented to scientific endeavor. Management science however, has provided both a frame of reference, in Information-Feedback Control Theory, and a terminology that has been a stimulus for the interjection of order in the disarray of traditional management control theory.

Traditional management theory can make a significant contribution to management science and to systems design by distinguishing well founded analogies from the superficial similiarities of other systems, and by identifying interacting variables and parameters in simulation models of management processes. It can further contribute by diverting attention away from the highly attractive technological achievements in data handling to the more important problems of management information needs and control responsibilities and toward an emphasis on "better" information rather than "more" information, better "control" rather than "more" control.

There is a basic unity of purpose in the efforts of the traditional and management science schools as well as a complimentary relationship in their contributions and it has been predicted that these and other schools of management thought will ultimately merge. Although the lack of a unified theory of management has long been decried, efforts to achieve a unified theory of management or any significant aspect of management have been notedly unsuccessful. Any widely applicable theory of management, regardless of its source, must be stated in terms of generalizations and is, therefore, incapable of proof. Such a theory would probably fail to gain wide acceptance. Thesis and antithesis rather than synthesis appears the prospect for management theory in the foreseeable future.

The existence of two theoretical bases of management thought is not necessarily an undesirable condition. Through feedback, mutual enrichment and reinforcement both can continue to grow. As terminology becomes more uniform and recognition of the contributions and accomplishments of each develops, rapport between the divergent groups should improve and management as an art and management as a science should continue to grow, although on separate and non-convergent paths. Management as an art is based on generalizations developed from observation and experience. Management as a science generalizes from analogy and experimentation. Both have their place in modern management thought; both can contribute to an understanding of the phenomenon we call "management control."

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